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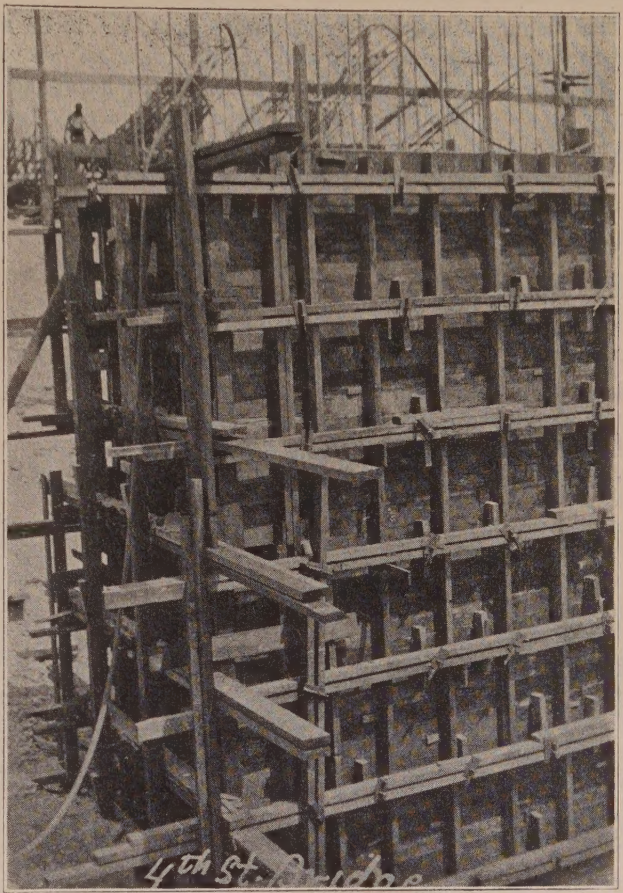
Unusual Forming Methods

Employed on Los Angeles Viaduct

Appearance of Exposed Concrete Stressed—Form Work Fabricated and Assembled in Units

By ROBERT YOUMANS
General Superintendent, Fisher Ross McDonald & Kahn, Inc.,
Los Angeles

ONE of the outstanding features in the construction of the new Fourth Street viaduct at Los Angeles was the emphasis placed on the appearance of the exposed concrete surfaces. The design of the viaduct called for a great deal of surface ornamentation, all of which was cast in place monolithically with the structural concrete. There are many offsets with straight line and angle effects, requiring particularly careful form work and the placing of concrete that would set the designs off to the best advantage.

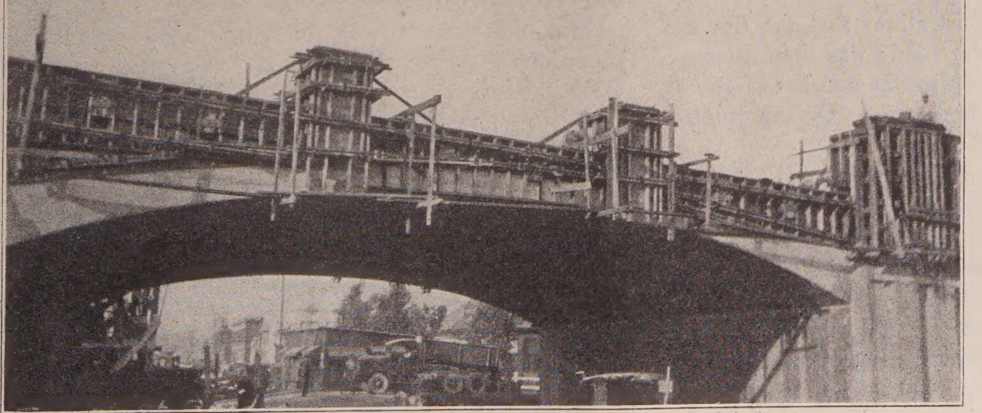


Pier form work, showing use of 2-by-4 wales and studs

In order to attain these desired results most surely and most economically, the contractors—Fisher Ross McDonald & Kahn, Inc.—developed a method of building up the forms in units at a central form yard adjacent to the job, and assembling these units in place on the viaduct. Approximately 90 per cent of the exterior form work was fabricated and assembled in this manner.

The concrete, also, was carefully controlled to secure both the plasticity and density needed for exposed work of this kind.

The Fourth Street viaduct spans the Los Angeles River



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Use of pre-made form panels in Fourth Street viaduct

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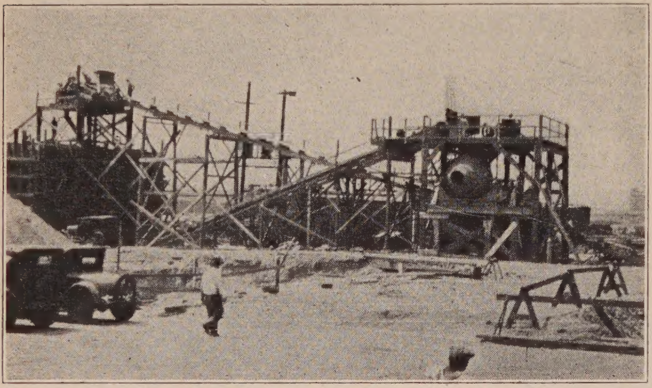
as well as the main line trackage of both the Union Pacific and the Santa Fe Railroads. It is 3,200 feet long over all and has three approaches, affording uninterrupted traffic flow across a section that had previously been very difficult for motorists.

The viaduct consists of eight arch spans, including a 254-foot spring hinge arch and seven arches of about 70-foot span. In addition, there are eighteen beam-and-girder spans with arched smoke slabs underneath. Ten mammoth abutments were required, some of them rising 112 feet from the bottom of the footings to the top of the pylons. More than 44,000 cubic yards of concrete were required.

Form Details

The specifications for the form work were very rigid, holding the contractor to a minimum variation. The result was that forms were built with cabinet-like accuracy in units of varying sizes and then erected in place.

The contract requirements necessitated the erection of the arch forms in place, but all other exterior forms, comprising about 90 per cent of the total exposed surface, were fabricated in the form yard. By this method greater accuracy was possible in the fabrication as well as in the erection of the units. It was necessary to hold the pre-fabricated units to absolutely true line and elevation. To do this about 4,500 sets of Willard rod ties were used, the rods varying from 12 inches to 39 feet in length. The selection of the rod ties for this job was the result of their performance during the construction of the Los Angeles County hospital, one of the largest monolithic concrete buildings ever constructed, and other similar structures where accurate alignment of forms was essential.


The central concrete mixing plant for 3,200-ft. viaduct

It will be seen from the illustrations that the ties are placed at rather close intervals. This was done to meet the city specifications, which require the spacing of ties at stipulated intervals, as shown in Table I. On this job the ties were placed to take care of an 8-foot pour.

Another specification requirement was that any bolt or metal form accessory that extends into or through the concrete must be cut back to a point 1 inch from the exposed surface and the hole neatly patched with concrete. With the ties used, this requirement was easily met by simply unscrewing the cone at the end of the tie. The threads on the embedded rod provided a secure anchor for the patching concrete.

TABLE I

TABLES FOR SPACING ½-INCH FORM BOLTS

Two 2-by-4 Wales

2 by 4-in. Studs Spaced 18 In. Apart

Under given rate of placing, in ft. per hr., read spacing of form bolts, in in.

Rate of placing, in ft. per hr.	1	2	3	4	5	6	7	8
Depth in ft., from top:								
0-5	45	41	37	35	34	33	32	32
5-10	41	37	34	32	31	30	29	29
10-15	38	34	32	30	29	28	27	27
15 and up	35	32	30	28	27	26	25	25

2 by 4-in. Studs Spaced 24 In. Apart

Under given rate of placing, in ft. per hr., read spacing of form bolts, in in.

Rate of placing, in ft. per hr.	1	2	3	4	5	6	7	8
Depth in ft., from top:								
0-5	42	39	36	34	32	31	30	29
5-10	38	35	33	31	29	28	27	26
10-15	35	33	30	29	27	26	25	24
15 and up	33	31	28	27	25	24	24	23

The sizes of the various units were determined by the specifications covering the placing of the concrete and by convenience in fabrication and erection. All posts were cast in one operation from the footings to the tops of the caps. Spandrel walls, also, were cast in a single operation from the footings up to the sidewalk lines. Forms for the posts and the spandrel walls were pre-fabricated in single units and erected in place. The outside forms for the pylons were fabricated in the yard and joined to the forms erected in place. It was demonstrated that this method of form fabrication will result in lowered costs when facilities for erecting the units are at hand and when the job is properly planned.

Specifications called for select common Douglas fir, except that where tongue and groove lumber was specified grade C Douglas fir flooring was employed. The forms were surfaced on one side and on both edges. All exterior forms were sanded with an electric sander and oiled.

All plaster molds and casts were molded before building the forms, thus assuring a neat take-off between the plaster and the wood forms. Plaster molds were used to form the ornamentation at the base of the exterior columns of the main 254-foot arch.

Form units were built on large wooden platforms. About two experienced finish carpenters were constantly at work fabricating the units. Form yard equipment included two power saws, a band saw and several portable Skilsaws.

Job Layout

Aggregates were delivered to the job in trucks. When the trucks reached the job, they backed up onto a slightly raised platform and dumped into a receiving hopper located below the ground level. A 24-in. belt conveyor then transported the aggregate to a revolving chute, where the aggregates were separated as to size and conveyed to their respective hoppers.

Employ Five Sizes of Aggregate

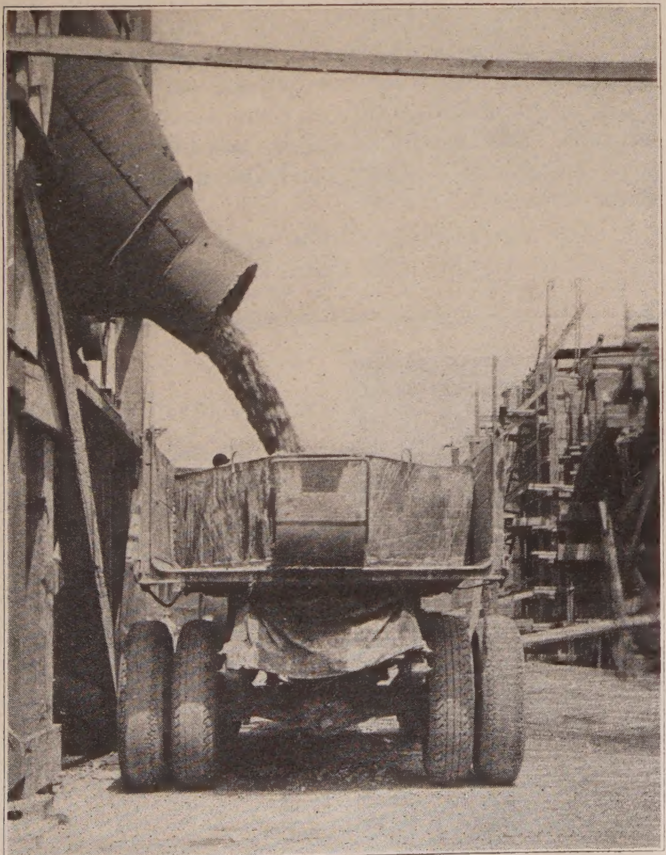
Two sizes of sand and three sizes of rock were recombined by weight to secure the grading desired. The proportions used approximated a 1:2:3 mix, but minor changes were made from time to time to secure the desired results. Sand was separated into two sizes—plaster sand and concrete sand, having particles up to ¼-in. in size. Rock was separated into three sizes—pea gravel, ¼-in. to ⅜-in.; ⅜-in. to 1-in.; and 1-in. to 1½-in. The various sizes were stored in separate compartments above the measuring hoppers. A Madsen Iron Works batching plant, employing the weight method of proportioning, was used. Concrete was mixed in a 56-S Smith tilting mixer.

After mixing, the concrete was transported by trucks to a receiving hopper from which it was elevated by a gas-air crane to a second hopper. From this hopper it was distributed to the forms in buggies.

One of the principal requirements was the appearance of the finished concrete. Workability was an important consideration because it affected appearance. Strengths were variable because slumps ranging from 3 in. to 7 in. were used, depending on the type of work.

The work was done under the direction of J. J. Jessup, city engineer for Los Angeles. Merrill Butler is engineer of bridges and structures, and H. F. Cortelyou is chief of the bureau of inspection. L. E. Meidroth is resident engineer for the city.

The writer is superintendent for the contractors, A. Donaldson is field engineer and S. E. Joseph is detail foreman in charge of the fabrication of the form units.



Trucks delivered concrete from central mixing plant to hoist hoppers

Thickness of Mortar Coating on Aggregate Particles

Archie A. Smith Explains Determination of Computed Thickness Employed in Article in September Issue

The October issue of CONCRETE, page 18, contains a letter from D. D. McGuire in which he comments very favorably on the method of proportioning concrete explained by Archie A. Smith in the September issue, pages 17 to 19.

Mr. McGuire, however, requests information as to how the author arrived at the thickness of cement paste on sand particles and cement mortar on coarse aggregate particles. In the paragraphs that follow, Mr. Smith supplies the information requested.

The weighted average size or diameter of a particle of portland cement is about 0.0015 in. The water-cement ratio used in the illustrative example is 1; then the yield of cement paste is 1.49 cu. ft., or practically 3 times the absolute volume of 1 sack of cement, taken as 0.49 cu. ft. The final unit or subdivision of the paste, which is the volume of paste per cement particle, would equal 3×0.0015^3. Considering the volume of paste as the cubical expansion of the absolute volume of the cement, the edge dimension of this unit volume would equal

$$\sqrt[3]{3 \times .0015^3} = .0022 \text{ in.,}$$

which is used as the thickness of the paste coating on the sand grains.

The final subdivision of the mortar in this case would be the weighted average grain of sand with its coating of cement paste 0.0022 in. thick (the factor 0.0032 was used by mistake). The weighted size or diameter of the sand grain is 0.0486 in. Therefore, the thickness of the mortar separating the coarse aggregate pieces would be $0.0486 + (2 \times 0.0022)$, and the coating is taken as

$$\frac{0.0486 + (2 \times 0.0022)}{2} = 0.0265$$

instead of 0.0275 as used in the example.

The physical analysis of the coarse aggregate used in the illustrative example is that of crushed limestone. If the pieces of this aggregate are considered as cubes, the tables used in the example, which have been calculated for well rounded water-worn or glacial gravels, are made applicable to the crushed aggregate by applying the factor 1.24, the relation of the surface area of a cube to that of a sphere of equal volume. The factor 1.24 was used in calculating the surface area of the coarse aggregate.

The illustrative example was solved solely to illustrate the principle and a method of applying it. Extensive research through experiment and test is necessary to determine the paste and mortar thickness for different types of aggregate and concrete properties, as well as coefficients of form for use in obtaining the surface area.

The accompanying table shows the automatic effect on proportions of the aggregates used in the example, of five values of $\frac{W}{C}$.

$\frac{W}{C}$	Cement paste coat, thickness	Cement paste yield cu. ft.	Mortar coat, thickness	Mortar yield, cu. ft.		Cement	Sand	Coarse Agg.
0.70	0.0020	1.19	0.0263	2.24	Dry rodded	1	1.59	3.44
					Loose damp	1	1.97	3.68
0.80	0.0021	1.29	0.0264	2.40	Dry rodded	1	1.68	3.69
					Loose damp	1	2.08	3.96
0.90	0.0021	1.39	0.0264	2.58	Dry rodded	1	1.80	3.96
					Loose damp	1	2.24	4.24
1.00	0.0022	1.49	0.0265	2.74	Dry rodded	1	1.89	4.22
					Loose damp	1	2.33	4.51
1.10	0.0022	1.59	0.0265	2.93	Dry rodded	1	2.01	4.51
					Loose damp	1	2.50	4.83

Building a Market for Cast Stone

—Responsible Ownership an Important Advantage
—Developing Confidence in the Product
—Experiments with Glossy Finish
—A Reasonable Market Radius

BUILDING up a market for cast stone in a city that was accustomed to the extensive use of natural cut stone was the problem that faced the management of the Blue Jay Concrete Products Co., of Madison, Wis., when this company undertook the manufacture of concrete cast stone in 1926.

A Good Potential Market

The potential market in Madison for cast stone was considered a favorable factor. While the population of the city was only about 58,000 in 1930, and about 39,000 in 1920, the use of natural cut stone had always been much greater than in the general run of American cities of this size. This, of course, was due to the fact that Madison is not only the capital of the state, but the seat of the state university. In consequence, there is a large market for stone, either cast or natural cut stone. In addition to the use of stone as exterior and interior trim and wall facing in office buildings, hotels, club buildings, libraries, churches and schools, and in city and county administrative buildings, there are the state and university buildings.

Furthermore, the presence of the state government and the state university means that structures such as club buildings, hotels and office buildings are built in much greater number and more elaborate construction than in the general run of cities of equal population.

In a word, the market was present; but it was only a potential market, for prior to 1926 practically all architectural stone work was executed in natural cut stone.

Ownership an Important Factor

One of the first essentials in winning a place for concrete cast stone, aside from having sufficient capital and a properly equipped plant, is to have the ownership and management of the plant in the hands of men in whom the community has confidence. This advantage existed in the case of the Blue Jay Concrete Products Co.

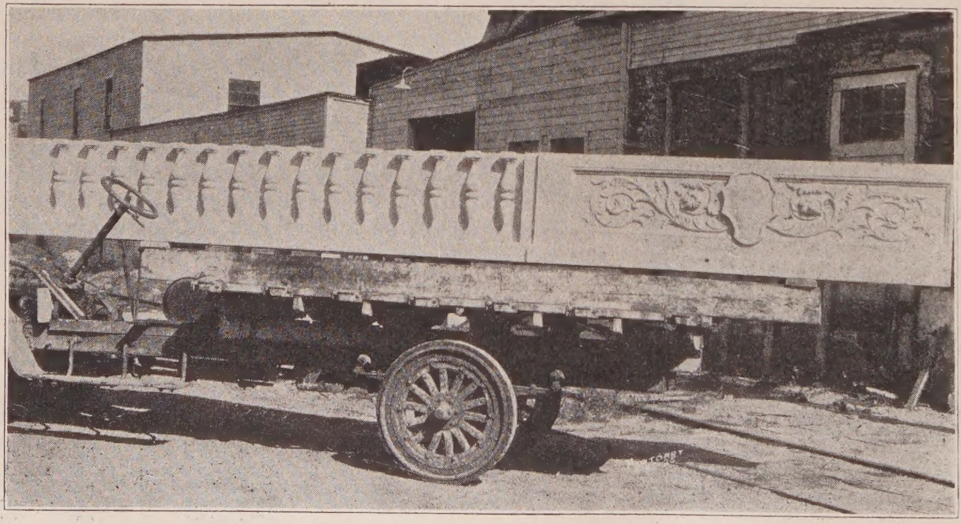
The advantage of having responsible ownership was especially noticeable in the promotion of this product with Madison architects. Almost invariably it made a distinctly favorable impression on an architect when he learned the names of the owners, all of whom are men of affairs in the business and professional life of the city.

Promoting Cast Stone on Quality

It is only re-telling an old story to say that at first the new material met with much sales resistance. A considerable part of that resistance was gradually overcome by promoting concrete cast stone with the architects and other leaders in the building industry of the city; but the management started off on the right foot by promoting the material on the basis of quality.

The management has always adhered to the policy of emphasizing quality. From the beginning representatives of the cast stone company made calls on architects, not too frequently, but sufficiently frequent to keep the idea of cast stone before them. Samples of the material were left at their offices. The density and consequent low absorption of the cast stone were pointed out to them, both by means of test reports and common-sense visual observation. The meaning of density and low absorption—good resistance to weathering and little absorption of soot—was explained.

Usually only a few calls were required to get an architect interested to the point where he visited the manufac-



Large cast stone balustrade unit 26 ft. long and 34 in. deep being transported to site of Eastwood Theatre, Madison, Wis.

turing plant. Here he was taken through the entire process of manufacture and curing, including the drafting and mold-making department. He saw the delivery equipment, and the methods of delivery were explained. He was told something about the company's ability to produce in large quantity. In most cases he went away with confidence in ability of the cast stone organization to manufacture a product of high quality in any design desired, to produce it in sufficient quantity to meet the building schedule, and to deliver it in an undamaged condition.

When an architect had gone this far it was felt that sooner or later he would specify cast stone. Ordinarily, however, the advantage was pushed further by taking him around to buildings where the company's cast stone had been placed or where it was in course of erection. This gave him an opportunity to see cast stone as it actually appeared in a building, and his confidence was further increased.

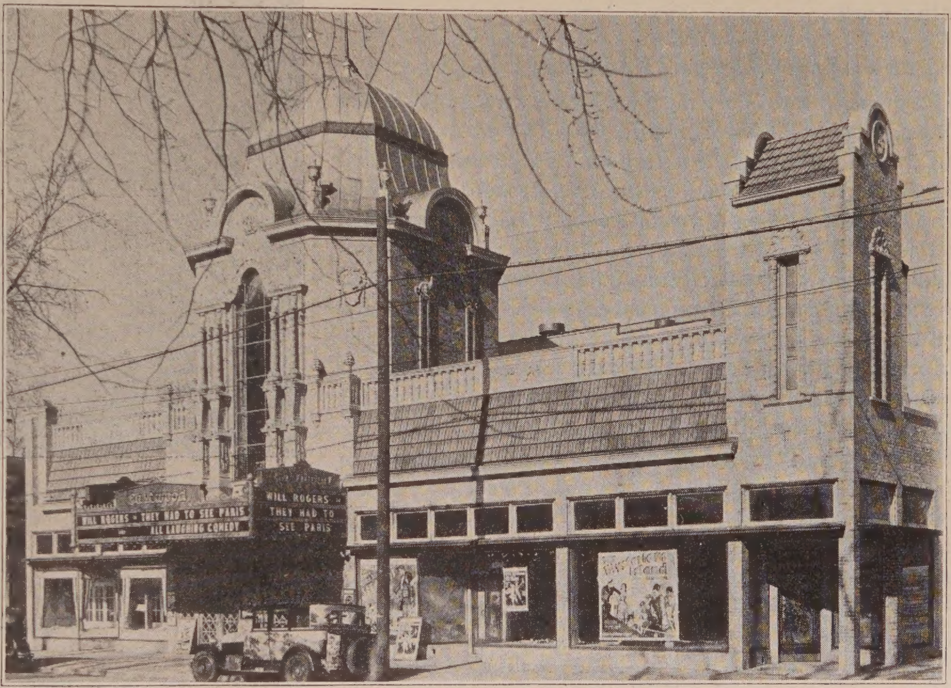
Avoiding Price Arguments

Neither during this period of promotion nor at any other time was the price argument advanced. The management of the cast stone company undertook definitely to convince the architects of the city, individually and collectively, that the cast stone made at its plant is superior to—not cheaper than—natural cut stone.

The manager of the Madison plant has expressed the opinion that one of the biggest mistakes made by many concrete products manufacturers who enter the cast stone field is that of predicating their sales efforts on the fact that their product can be obtained at a lower price than natural cut stone. The instant that the argument of lower price is advanced to the prospect, he goes through one or both of two mental calculations. First, he may get the impression that if cast stone is lower in price it may also be lower in quality. Second, the suggestion of lower price may start him to thinking about still other materials that may be obtained at a price still lower.

Trying to Reach Too Far

Another serious mistake often made by manufacturers of cast stone, according to the manager of the Blue Jay plant, has its source in the foolish effort for production volume regardless of profit. This effort often takes the form of attempts to sell over a wide area. When a manufacturer pays too much attention to distant out-of-town prospects he is in danger of overlooking a prospect nearer home. Then, too, he may be stirring up ill feeling when he invades territory that logically belongs to others. The Madison plant, for illustration, might bid on a contract in Milwaukee at cost, in order to keep its forces busy. Then, under similar circumstances, a Milwaukee manufacturer of cast stone might bid on a job in Madison at cost. The net result would be the waste of both contracts so far as profits are concerned. No one would have benefited, but plenty of ill will would have been created.



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Eastwood Theatre, Madison, Wis. Concrete cast stone is used in the exterior trim and ornamental work. The large unit in the other illustration appears at the right of the main tower

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A Reasonable Market Radius

The general policy of the Blue Jay Concrete Products Co., so far as out-of-town prospects are concerned, is to keep away from territory that lies within the proper sphere of another plant.

In addition, the plant manager desires to have all contracts within a distance that will permit driving there and back again the same day. It is his duty to keep in touch with all contracts, to see that the cast stone is being handled and placed properly, as well as to look after the general management of the plant itself. It would, therefore, be a handicap to proper plant management if out-of-town trips were to consume several days at a time.

The Advantage of Small Contracts

It has generally been found, in the experience of the

Blue Jay Concrete Products Co., that small contracts are proportionately more profitable than large contracts. To express the comparison in actual figures, five $3,000 contracts will probably bring in a greater profit in the aggregate than two $10,000 contracts.

On a small contract the manufacturer deals mainly with the architect, who knows his business and who must have thought well of cast stone before he specified it. On a large contract the story may be quite different. Here there is usually a building committee to deal with, often resulting in plenty of grief for both the manufacturer and the architect.

It is, therefore, a serious error of judgment, in the opinion of the plant manager, for a manufacturer of cast stone to consume all his time in running down the large prospects. He will find less sales resistance and more profit in the aggregate if he pays proper attention to the smaller work.

Care in Transporting and Handling

The greatest care must be exercised in transporting and handling cast stone during delivery. The plant management that is careless in this respect, and permits material to be delivered with corners and points broken off, may as well go out of business. Architects will not tolerate such practices, and with good reason.

Units to be transported must be properly packed to prevent damage, and equipment must be available for handling large units. Furthermore, large units must be reinforced with steel during the process of manufacture, to facilitate handling. In some cases the steel acts as structural reinforcement after a large unit is set in place.

This is virtually the case with the large unit shown in the illustrations, which, in the completed structure, forms the balustrade at the top, extending from the right of the main tower to nearly two-thirds of the distance toward the corner tower. This huge cast stone unit is 26 ft. long and 34 in. deep. It is 9 in. thick at the ornamental panel, while the section that backs up the balusters is 4 in. thick.

The unit was reinforced at top and bottom. Lift hooks were cast into the stone a short distance from each end.

Experiments with Glossy Finish

The Blue Jay Concrete Products Co. has done some experimentation with the view of obtaining a glossy finish without mechanical polishing. Samples of three commercial admixtures were obtained, and other experiments are being conducted on the company's own account, but the effects thus far obtained are not entirely satisfactory.

With the development of a glossy finish that is commercially successful a rather large market can be developed in products such as ornamental wall tile for both interior and exterior work. This market exists in Madison, as previously explained, because of the relatively large number of buildings of a public and semi-public character erected in periods of normal construction activity.

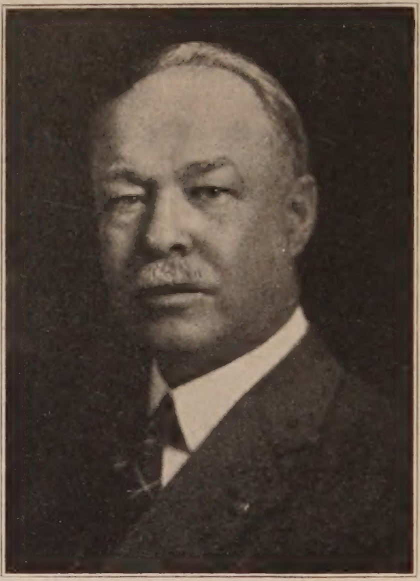
The plant of the Blue Jay Concrete Products Company is in a close-in location, served by a railway siding. The building is a 2-story structure formerly occupied by another industry, but the interior was rearranged to suit the requirements of concrete products manufacture.

C. Clare is manager of the Blue Jay Concrete Products Co., whose plant is located at 2010 Pennsylvania Avenue, Madison, Wis.

Col. Ernest McCullough Passes Away in East

Col. Ernest McCullough, engineer, editor and world war veteran, died at his home in New York on October 1, following a short illness.

Born in Staten Island, N. Y., in 1867, Col. McCullough spent most of his engineering career in the far west and in Chicago.



Col. Ernest McCullough

After graduating from Throop Institute, now the California Institute of Technology, in Pasadena, Calif., he settled in San Francisco in 1887, where he followed engineering and served as editor of *The Engineer and Contractor* until 1898, when he moved to Lewiston, Idaho. In the Idaho city he held the office of city engineer and engaged in private practice until 1903.

From 1903 to 1917 Col. McCullough lived in Chicago, practicing structural and municipal engineering. During this period, though he held an architect's license under an Illinois law, he worked unceasingly for the adoption of a structural engineers' license law, finally succeeding in obtaining the passage of a bitterly contested state law in 1916. In this campaign he sacrificed much of his time and private funds.

During the world war Col. McCullough served in France and was wounded in the battle of Cambrai. During that period he was chief gas officer for the First Army Corps and chief engineer for the American Red Cross.

After the war Col. McCullough returned to New York, where he was structural engineering editor for *The American Architect* and later editor-in-chief of *Building Age*.

Throughout his entire career he was a prolific writer, having contributed many magazine articles to engineering and architectural publications, and written a number of books. As an author of books on engineering he wrote "Farm Drainage," "Municipal Engineering Work," "Engineering Work in Towns and Cities," "Engineering as a Vocation," "Practical Surveying" and "Practical Structural Design.'

His wife, Mrs. Therese Claquin McCullough, and three children by a former marriage—Captain Seymour McCullough, of Governors Island; James D. McCullough, of Staten Island, and Mrs. Paul C. Galleher—survive. Colonel McCullough's first wife, Elizabeth Townsend Seymour, died in 1918.

Co-Ordinated Laws of Concrete Mixtures And Their Application

Basic Principles of Science and Practice of Concrete-Making Clarified — Complete Method of Procedure Provided

By JOSEPH A. KITTS
Consulting Concrete Technologist, San Francisco, Calif.

Certain preliminary developments in the co-ordination of the laws of concrete mixtures were presented to readers of *Concrete* by this author in the issue of November, 1929.

The present article offers a more thorough and more simplified development of this important subject of the control of concrete production as a manufacturing process.

This installment includes only the statement of the problem, and the test procedure in determining the physical characteristics of aggregates. Next month's concluding installment sets forth the procedure for making mixture calculations. Tables 2 to 6, inclusive, and Equations 10 to 16a, inclusive, will appear in next month's issue.—The Editors.

THIS is the first co-ordination of the fundamental principles of mixtures developed by the world's leaders in the science and practice of concrete making. It is in strict accordance with all the established principles of mixtures; provides the first complete calculation method in the history of concrete; and is so simple and fundamental that the tests and calculations are learned by the technical student in a few days.

This development has been made in connection with the production of some 4,000,000 cu. yd. of concrete, and the complete co-ordination has been employed with marked success on the technological control of some 240,000 cu. yd. since January, 1929. It has particularly met the local requirements of central plant proportioning and transit mixing, where accuracy in strength, yield and consistency is demanded from the first to last load and cut-and-try methods are taboo.

The laws of the optimum cement content and fineness modulus, discovered by the writer in January, 1929, are in strict accordance with the data found in "Design and Control of Concrete Mixtures," Second Edition, January, 1927, published by the Portland Cement Association. The constants, presented in Tables 2 and 5,[1] have been found very accurate, for the grading and consistency of mixtures of gravel aggregates, and quite conservative in the indication of strength.

The co-ordinated procedure of aggregate tests is a development in connection with testing and practical production of several million cubic yards of concrete. It is practical, expedient, scientifically logical, and its accuracy is such that yields, within one-half of one per cent, are uniformly obtained for all mixtures.

The algebraic method of grading several sizes of aggregates, by the co-ordination of the Abrams fineness modulus principle with the Talbot grading equation, as comprehended by Equations 13, 14, 16, 16a and Tables 5 and 6,[1] is (the writer has found by extensive experience in proportioning three or more sizes) the most useful procedure in the formulation of mixtures of three or more aggregates, and is both expedient and accurate. Where it formerly required hours to obtain a grading of three or more aggregates by the various graphical methods, the algebraic calculation is accomplished in a few minutes. Table 6 is a new appreciation of the relations of the maximum size, fineness modulus, and the Talbot grading equation, and its compilation finishes this part of the algebraic calculation once and for all.

The preliminary development of this co-ordination of principles of mixtures was published in CONCRETE in November, 1929. The present article offers a more replete and simplified development and supplies the scientific and practical essentials for the technological control of concrete production as a manufacturing process.

The writer feels that it is his privilege to say, with sound appreciation as a student of the work of the world's leaders in concrete research and as a practical maker of concrete over a period of thirty-six years, that this development introduces the scientific age in the practical making of concrete; that it is the first conciliation of the fragmentary fundamentals of mixtures discovered by Feret, Thacher, Fuller, Abrams, Talbot, and the many other workers in modern concrete research; and, as such, provides the first complete process of technological control of concrete production.

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[1] Tables 2 to 6, inclusive, and Equations 10 to 16a, inclusive, will appear in the December issue of CONCRETE.

TABLE 1

Characteristics of Job Aggregates

Agg. No.	Max. Size D	Fineness Modulus $f.m.$	Loose-Moist Density d	Apparent sp. gr. g	Moisture by abs. vol. m	Absorption by abs. vol. a	Dry-rodded Density dr	Loose-dry Density dd
I	#16	1.81	0.511	2.61	0.171	0.050	0.631	0.551
II	¼″	3.92	.582	2.62	.102	.042	.662	.612
III	⅝″	6.03	.573	2.63	.053	.033	.633	.593
IV	1⅛″	7.04	.564	2.64	.034	.024	.594	.574
V	1⅜″	8.05	.555	2.65	.025	.015	.585	.565
VI	3″	8.86	.566	2.66	.020	.010	.586	.566

When this concrete technology becomes generally known, the structural engineer will then have confidence to adopt the more economical bases of structural design, 3,000 or 4,000-lb. concrete, instead of 2,000-lb., as is now the general practice. The resulting economy of concrete construction will greatly benefit the cement and concrete industries and the corresponding technical services. In view of these facts, the writer is glad to publish his business process for the general welfare.

Basic Laws of Concrete-Making Co-ordinated

This article co-ordinates the basic principles of concrete mixtures developed by Thacher, Feret, Fuller, Abrams, Talbot, and the author. It co-ordinates the following six laws of mixtures: (1) Cement Content, (2) Water Content, (3) Aggregate Content, (4) Aggregate Fineness Modulus, (5) Aggregate Grading and, (6) Yield of Combinations.

The most fundamental law of mixtures of aggregates, cement, and water is that ***absolute volume is the basic measure of the ingredients.*** The volume of concrete obtained from a mixture of ingredients is equal to the sum of the absolute volumes of the individual ingredients with a small plus correction for entrapped air and minus correction for cement going into solution with the mixing water. This basis simplifies and clarifies the whole subject of the laws, physics, and technology of concrete mixtures.

"Absolute volume," as used herein, is generally termed "apparent volume" by concrete physicists. In the case of aggregate particles, it is the volume contained within the surfaces of the particles, including the porosity of the particles but exclusive of the void spaces between particles. It is the volume of water at any usable temperature. The absolute volume corresponding to one average cubic foot bulk volume of standard portland cement, one sack, or 94 lb., is 0.485 cu. ft. for an average specific gravity of cement of 3.105.

TESTS OF AGGREGATE CHARACTERISTICS

Tests of the physical characteristics of job aggregates are essential in order to weigh out or bulk measure the required absolute volumes, compensate for moisture content and absorption and maintain a uniform structure of gradation of sizes of particles. A co-ordinated test procedure is as follows: (Aggregate No. I is used in the example.)

Aggregate Tests:	Example:
Test A—Weigh water exactly filling standard container	6.24 lb.
Test B—Weigh loose-moist aggregate filling container	8.868 "
Test C—Surface-dry B and weigh	8.482 "
Test D—Dry C at 212 deg. F. and weigh	8.322 "
Test E—Weigh D inundated, exactly filling container with water	11.373 "
Test F—Weigh dry aggregate filling container, rodding in the standard manner	10.277 "
Test G—Weigh loose dry aggregate filling container	8.974 "
Test R—Make standard sieve analysis finding proportions of total aggregate retained on and coarser than each of the standard sieves Nos. 100, 50, 30, 16, 8, 4, ⅜-in. ¾-in., 1½-in., etc.	

Note: The notation used herein refers to the particular subject and does not have the same meaning throughout.

Calculations:

d = loose-moist density = $(A - E + D)/A$ = 0.511 .... (1)

g = apparent specific gravity = D/Ad = 2.61 .... (2)

a = absorption by absolute volume = $(C - D)/Ad$ = 0.050 .... (3)

m = moisture by absolute volume = $(B - D)/Ad$ = 0.171 .... (4)

w = weight of moist aggregate in lb. per cu. ft. by absolute volume = $62.4\ (g + m)$ = 173.534 .... (5)

b = loose-moist bulk volume corresponding to a unit absolute volume = $1.0/d$ = 1.957 .... (6)

dr = dry-rodded density = F/Ag = 0.631 .... (7)

dd = loose-dry density = G/Ag = 0.551 .... (8)

$f.m.$ = fineness modulus = $R_{100} + R_{50} + R_{30}$ + etc. .... (9)

Job Aggregates and Cement

Assume that we have a normal standard portland cement and that physical characteristics of the job aggregates are as given in Table 1.

(To Be Continued)

Highway Research Board Annual Meeting in December

The Eleventh Annual Meeting of the Highway Research Board, National Research Council, will be held on December 10 and 11, in Washington, D. C. The meetings will be in the auditorium of the National Academy of Sciences, 2101 Constitution Avenue.

Sessions will be devoted to discussions of reports of research activities in relation to highway finance, transportation, design, materials and construction, maintenance and traffic.

Precast Concrete Pipe Sewers Exceed Designed Capacity

Infiltration of Ground Water Only One-Eighth of Amount Allowed by Specifications—Joint Details and Methods of Construction

By EMERSON C. HALLOCK
Chief Inspector, Westchester County Sanitary Sewer Commission, White Plains, N. Y.

THE trunk line sewers for the Westchester County (N. Y.) Sanitary Sewer Commission follow, for the most part, along the Mamaroneck River, Mamaroneck reservoir, and the Beaver Brook stream, crossing the streams at several points. The lines are laid from 3 to 5 ft. below the bottom of the nearby streams, so that connections can be made under them from either side.

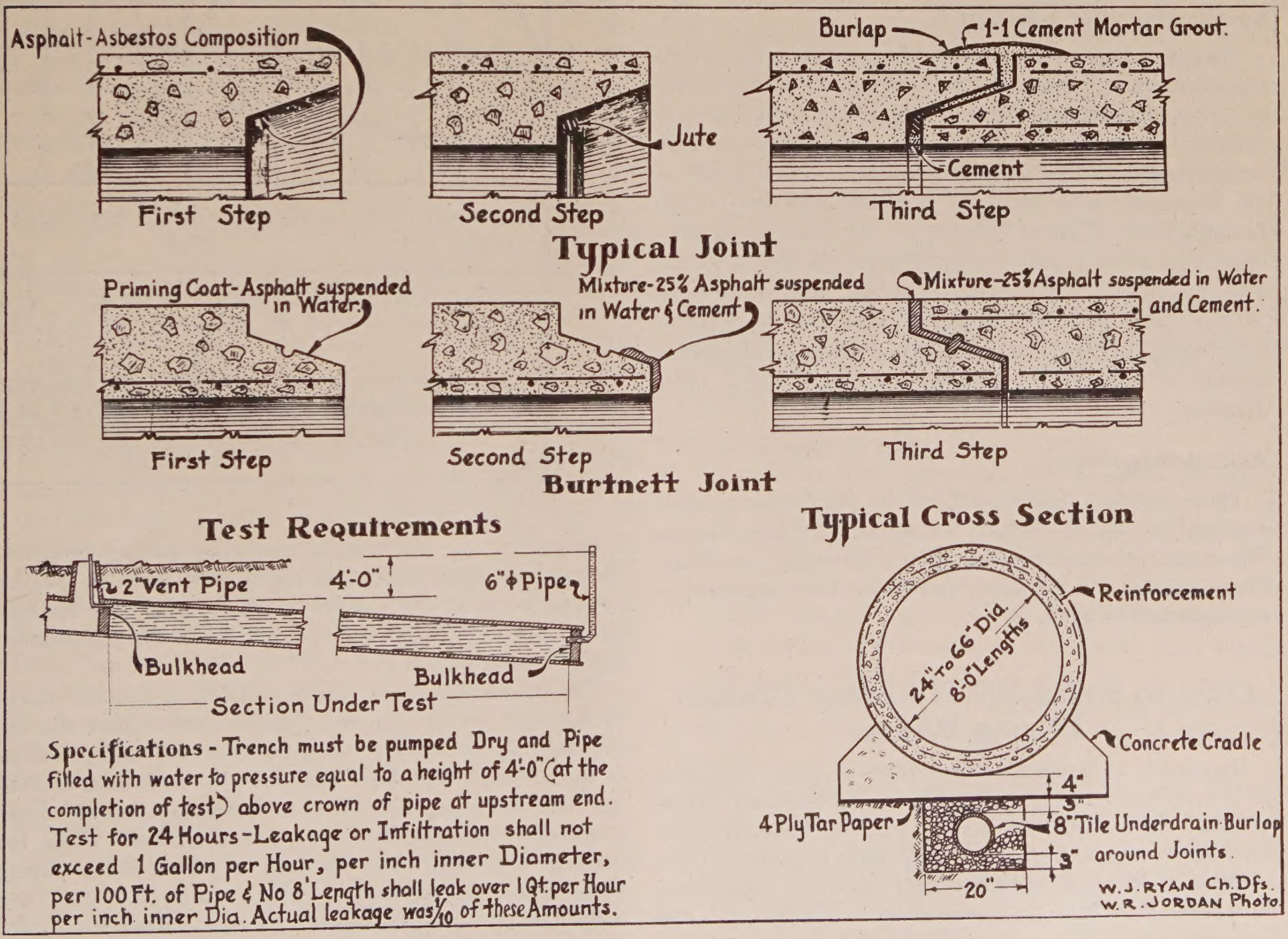
Practically the entire line was far below ground water level, so that the utmost care was taken to insure a permanent and tight line and to prevent seepage into the sewer.

A few of the sewers were built of cast iron pipe from 14 to 24-in. diameter and 12-ft. lengths, laid on crushed stone with a vitrified tile underdrain. A 40-lb. air test was applied on all cast iron pipe, about 23,000 ft. being used.

Larger Sewers of Precast Reinforced Concrete Pipe

Most of the sewers, however, were from 24 to 66-in. diameter. Here 8-ft. lengths of precast reinforced concrete pipe were used, laid on a concrete cradle, with crushed stone and a vitrified tile underdrain under the cradle, about 66,000 ft. being built. For testing, a 4-ft. internal head was placed on all concrete pipe before backfilling. The average test was only a fraction of the amount allowed under the specifications.

The total infiltration of ground water allowed by the



Specifications - Trench must be pumped Dry and Pipe filled with water to pressure equal to a height of 4'-0" (at the completion of test) above crown of pipe at upstream end. Test for 24 Hours - Leakage or Infiltration shall not exceed 1 Gallon per Hour, per inch inner Diameter, per 100 Ft. of Pipe & No 8' Length shall leak over 1 Qt. per Hour per inch inner Dia. Actual leakage was 1/10 of these Amounts.

Construction details of precast reinforced concrete pipe sewers specifications was more than 725,000 gallons for 24 hours, while the actual infiltration showed a maximum of 86,000 gallons for 24 hours. The actual infiltration into the concrete pipe sewers is so much less than expected that the system will take care of a much greater population than was originally designed for.

Making Up Joints on Precast Concrete Pipe

The drawings show the methods employed in making up the joints in the precast concrete pipe. First, a composition of asphalt and asbestos was placed around in the sleeve-end of the pipe which was in the trench; second, a thick continuous strand of jute was then packed into this compound; third, the spigot end of the next pipe was inserted into this bell and shoved home, the spigot end forcing jute and sewer compound into the groove of the sleeve-end; fourth, more jute was caulked into the joint if needed; fifth, the remainder of the joint was filled tight from the inside with 1:1 mortar; sixth, a piece of burlap was placed around the outside and made tight, then the outside of the joint was poured with a thin grout. The concrete cradle was placed before making up the joints, as this prevented any settlement taking place, after the joints are completed.

To stop joints from cracking, due to temperature changes in hot weather, it was found desirable to place tar paper a foot or so above the pipe, allowing an air space, which helped considerably.

Specifications for Leakage

The specifications for leakage in concrete pipe sewers state that water shall be raised inside of the sewer barrel to give a pressure equivalent to a height of 4 ft. above the exterior crown of the sewer at the upstream end of each section tested. When making a test with water inside of the sewer, all water shall be excluded from the trench. Leakage from inside or infiltration from outside the concrete pipe sewer during a continuous 24-hr. test shall not exceed a rate of 1 gallon per hour per inch of diameter of pipe, per 100 ft. of completed sewer, and no joint or 8-ft. lengths of pipe in the completed sewer shall leak an amount in excess of 1 quart per hour per inch of inner diameter.

Acknowledgments

These precast reinforced concrete pipe sewers were designed by W. W. Young, consulting engineer for the Westchester County Sanitary Sewer Commission, White Plains, N. Y., and the writer served as chief inspector on the construction work.

Ohio to Build 300 Highway Bridges During Winter

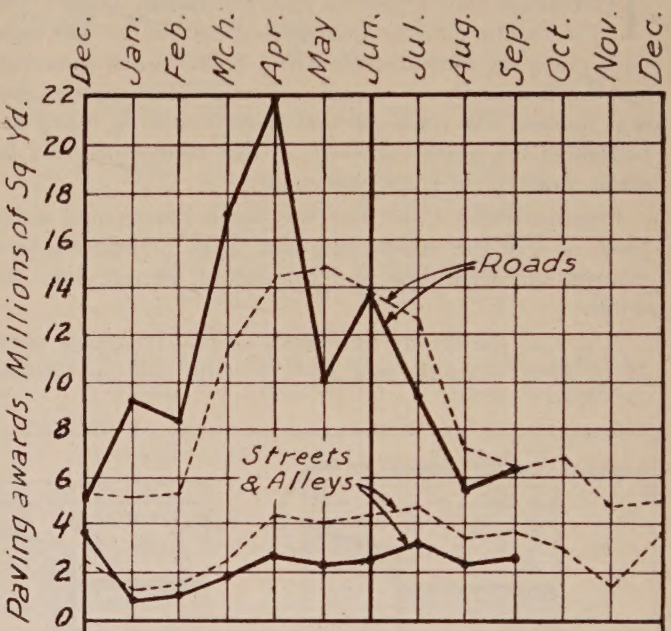
How work on highways can proceed in winter is shown by the program recently mapped out by Governor White of Ohio. In that state the amount of money usually spent for bridges will be augmented materially to permit of the building of 300 bridges located near centers of population. It is planned to have the contracts let by November 1 and contractors will be required to proceed with the work regardless of weather conditions.

Concrete Highway Paving Awards Continue in Good Volume

Street and Alley Paving Lags—Illinois Minimum Wage Law Declared Void

Concrete paving awards, both in roads and in streets and alleys, show a significant rise for the month of September, as compared with August, according to reports compiled by the highways bureau of the Portland Cement Association.

For the first 9 months of 1931 the total concrete road contracts amount to 101,596,882 sq. yd., more than 10 million sq. yd. ahead of the 91,314,083 sq. yd. for which contracts were awarded in the first 9 months of 1930.



Dotted lines indicate 1930 contracts
Solid " " 1931 "

Total concrete paving contracts, in Sq. Yd., in first 9 months of year—

	1930	1931
Concrete Roads--	91,314,083	101,596,882
Streets & Alleys---	29,659,639	19,157,603
Totals--	120,973,722	120,754,485

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Because of the lag in street and alley paving, however, the total of 120,754,485 sq. yd. for all concrete paving awards in the first 9 months of this year is very slightly under the 120,973,722 sq. yd. awarded in the corresponding part of last year.

The Illinois situation, where millions of dollars' worth of highway paving and other public construction was being held up because of disputes over the interpretation of the so-called minimum wage law, has now been cleared up. The state supreme court, on October 19, handed down a decision declaring the law unconstitutional. While the decision may have come too late to permit much paving to be done in advance of cold weather, the state and county highway departments can now proceed with the construction of bridges, grade separation structures, and similar projects where the work can be inclosed.

Pavement Concrete Studied Under Construction Conditions

Report Conclusions on Arlington Experimental Road Concrete—How Varying Quantities of Coarse Aggregate Affect Properties of Concrete

By F. H. JACKSON[1] and W. F. KELLERMANN[2]

THE tests which are reported in this paper were undertaken primarily for the purpose of determining the effect of variations in the quantity of coarse aggregate upon the strength, density, and other properties of concrete pavement slabs which had been placed and finished in accordance with normal field practice.

Experience in the use of multiple sizes of coarse aggregate in concrete pavement work in North Carolina and other states during the past few years has indicated the possibility of increasing the quantity of coarse aggregate per unit of volume of concrete beyond the limit which had previously been considered good practice and in this way producing a denser as well as a more economical mixture, provided only that the uniformity of the grading of the coarse aggregate and therefore its void content was controlled rigidly by handling and measuring it in separate sizes.

It was realized at the outset that an investigation of this sort, involving as it did that most elusive property of concrete which we call "workability," could not be performed satisfactorily in the laboratory. In spite of strenuous efforts on the part of many investigators, no satisfactory laboratory test for workability has as yet been developed. Furthermore, this whole matter of workability is tied up so intimately with methods of handling and finishing used on the job that it is impossible to set up any laboratory standard which will give more than comparative results. In other words, a concrete which by some laboratory standard may be rated as "unworkable" may be quite workable under certain job conditions.

For this investigation the percentage of visible honeycomb in the concrete, as revealed by a careful examination of the slabs, all of which were constructed in accordance with standard field practice, together with the uniformity of strength as determined by testing beams taken directly from the pavement, has been used to measure the uniformity and therefore the workability of the concrete. On this basis any concrete mixture which can be so handled as to produce a uniform homogeneous slab without unduly raising labor costs or reducing efficiency in operation is "workable" concrete, and any concrete which can not be so handled is not workable, in spite of any rating which it may receive by some arbitrary test.

Project Described

In order to develop information along these lines, the Bureau of Public Roads during the summer of 1929 constructed an experimental concrete pavement 9 ft. wide and approximately one-half mile long, using standard construction methods and appliances throughout, except that provision was made for creating planes of weakness to permit the removal of the pavement in sections for test purposes. The pavement was built at the Arlington Experiment Station of the Department of Agriculture at Arlington, Va., on the right of way of an abandoned electric line. This provided a graded, well drained, level subgrade which proved ideal for the purpose.

A total of 265 sections, each 9 ft. in length, was constructed. The program called for the construction of six sections per day, three sections of each of two proportions, using a given type and gradation of coarse aggregate and method of finishing. In each group of three the water content was varied so as to produce a variable consistency ranging from the driest mix which it appeared possible to place without undue effort on the part of the finishers to a consistency approximating a 2 to 3-in. slump. No effort was made to produce wet consistencies such as have sometimes been used in the past, because it was felt that the dangers of overwet concrete are sufficiently well known and require no demonstration. On the other hand, the water-cement ratio method of proportioning, the adoption of which is being strongly urged, encourages the use of dry concrete, so that it seemed desirable to study mixtures of this sort rather than the wet consistencies which are recognized as undesirable by everyone.

Materials and Proportions

In order to cover adequately the question of type of coarse aggregate as it affected the workability of the concrete and therefore the limiting quantity which might be used with safety, a siliceous limestone having a rather sharp angular fracture and a bank gravel containing some crushed fragments were used in the tests. In addition, a limited number of sections were laid with blast furnace slag as coarse aggregate.

The cement was shipped by car direct from the mill to the site of the work and all of the cement came from one bin.

The fine aggregate consisted of sand from the Potomac river, having a fineness modulus of 2.65. It was realized, of course, that the grading and other characteristics of the sand used in these experiments would have a marked effect upon the amount of coarse aggregate which could be used. It is well known that in general the finer the sand the higher the percentage of coarse aggregate by

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Abstracted from 36-page illustrated paper in August (1931) issue of *Pubic Roads.*

[1] Senior Engineer of Tests, U. S. Bureau of Public Roads.

[2] Associate Materials Engineer, U. S. Bureau of Public Roads.

volume which may be employed without exceeding the limits of workability. However, it was obviously impossible to study any great range in fine aggregate gradations in a program such as this. It was decided, therefore, to use a single sand of average gradation with varying percentages of coarse aggregate, beginning at a value sufficiently low to insure a well-oversanded mix for the particular type of sand selected and increasing the amount of coarse aggregate by definite steps until a distinctly undersanded mix, as judged by laboratory standards, had been obtained.

The limestone was obtained from Martinsburg, W. Va.; the gravel from Fredericksburg, Va.; and the slag from Birdsboro, Pa. Each aggregate was ordered shipped to the job in three separate sizes, as follows: ¼-in. to ¾-in., ¾-in. to 1¼-in., 1¼-in. to 2½-in. The separated sizes were combined by weight to give the combined aggregate gradations.

An analysis was made of the base mix, 1:2:3½, used in these tests according to the Talbot-Richart mortar-voids theory.[3] Results of mortar-voids tests on the sand used, which were made by Professor Richart, of the University of Illinois, form the basis of this analysis. According to the mortar-voids theory, for materials similar in quality, the strength of concrete is a function of the ratio of the volume of voids to the volume of cement in the mix. The theory also holds that, for the type of plastic mix ordinarily employed in construction, the void characteristics of the mortar constituent may be used in investigating the probable strength of the concrete. This is possible because, for such mixes, the volume of mortar is greater than the volume of voids in the coarse aggregate, and the voids in the concrete may therefore be considered as made up of the sum of the air and water voids.

Conclusions Stated

For the materials, proportions, and methods of placing used in these tests the results of the investigation justify the following conclusions:

1. For a constant sand-cement ratio an increase in the quantity of coarse aggregate beyond the limits ordinarily employed in practice decreased the strength of the concrete in the pavement substantially in proportion to the amount of additional water required to maintain workability.

2. For corresponding increases in the water-cement ratio the percentage of reduction in flexural strength was somewhat less than the percentage of reduction in crushing strength.

3. The workability and uniformity in strength of the concrete was decreased in proportion to the amount of coarse aggregate added.

4. The workability of the concrete was greatly reduced by decreasing the maximum size and at the same time increasing the amount of fines in the gravel coarse aggregate, even though the corresponding variations in the percentage of voids in the gravel were small.

5. For the gravel concrete the reduction in workability for any mix caused by the use of the poorly graded gravel was greater than the reduction in workability caused by increasing the percentage of coarse aggregate in the concrete containing the well graded material.

6. For a given consistency as measured by the slump test, different gradations of gravel produced different degrees of workability.

7. For a given gradation of coarse aggregate the consistency as determined by the slump test measured the workability of the concrete.

8. For a given proportion, higher slab strengths were obtained with concrete having a medium consistency (2 to 3 in. slump) than with very dry concrete (¼ to 1 in. slump).

9. In order to secure satisfactory uniformity and freedom from honeycomb it was necessary to use a consistency corresponding to a slump of approximately 2 to 3 in.

10. The various types of finishing machine employed in these tests gave approximately the same results.

11. For concrete reasonably free from honeycomb, the strength of the control beams appeared to be a satisfactory measure of the strength of the corresponding pavement slab.

12. Neither the amount of honeycombing observed in the drilled cores nor the crushing strengths developed by the drilled cores measured the extent of honeycomb in the pavement slabs or the flexural strength developed by the pavement slabs.

Recommendations

On the basis of the information produced by these tests, the following recommendations are made:

a. That all specifications for concrete for pavements contain a definite requirement covering consistency. The slump test is recommended for this purpose.

b. That the use of paving mixes showing less than 2-in. slump should be discouraged.

c. That specifications for consistency of paving concrete to be finished by any of the methods now in use be revised when necessary to provide that the concrete have a consistency corresponding to a slump of from 2 to 3 inches.

~ PERSONALS ~

Prof. J. B. Butler has been named head of the civil engineering department of the School of Mines and Metallurgy, Rolla, Mo., following the retirement of Prof. Elmo G. Harris on September 1.

Prof. Butler has made a special study of the principles controlling the quality of concrete and is recognized as a specialist in that field.

He is a graduate of the Oklahoma A. & M. College and took a master's degree at the school with which he is now connected. He was with the Interstate Commerce Commission, Santa Fe Railroad, and engaged in public road work previous to joining the Missouri school in 1920.

Wellesley C. Harrington, agricultural engineer for the New York office of the Portland Cement Association, has resigned from that position to accept appointment as extension agricultural engineering specialist at Massachusetts State College, Amherst, Mass.

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[3] Bulletin 137, University of Illinois Engineering Experiment Station, 1923.

EDITORIAL

Sensible Requirements for Winter Concreting

ENGINEERS and architects who are charged with the task of supervising concrete construction during cold weather will get better co-operation from contractors when more reason is incorporated in the specifications and field practice covering the work.

Many specification writers have fallen into the habit of passing up this part of construction specifications with a requirement to the general effect that when the outside temperature is below freezing all materials shall be heated and the temperature within the inclosure shall be kept above 50 deg. F. for ten days.

This simplifies matters for the specification writer, but it raises havoc with the contractor. Just what can be gained in putting the contractor to the trouble and expense of heating the water, the fine aggregate and the coarse aggregate during a season when heating the water alone would be more than sufficient for the purpose? Why compel him to incur the expense of heating the large mass of coarse aggregate when it is unnecessary to heat coarse aggregate in the coldest weather in which concrete is likely to be placed? What advantage is there in compelling him to heat the inclosure for ten days when the concrete has attained its full designed strength in half that time?

The February (1931) issue of "Concrete" contains an abstract of a paper on the subject of concreting in cold weather, by two engineers who have had an unusually extensive experience in such work.

From their experience in cold weather concreting in Canada and the colder sections of the United States these men have learned that with outside temperatures not lower than 15 deg. F. only the mixing water needs to be heated—to about 180 to 200 deg. F. With expected outside temperatures ranging from 15 deg. above zero F. to 40 deg. below, they have found that heating the mixing water and the fine aggregate is sufficient, except that in the lower temperatures they generally use a 1-inch steam jet or a kerosene-burning torch in the mixer.

Of course in all cases it is necessary to protect the concrete and keep the inclosure warm during the hardening period; but the 10-day requirement is often excessively long and therefore unnecessarily expensive. Here again these two engineers have followed a definite practice. When dealing with heavy mass concrete they maintain the temperature within the protecting inclosure above 50 deg. F. until the concrete has attained a strength of at least 30 per cent of its designed strength. With small walls and structural members they maintain this temperature within the inclosure until the concrete has acquired its full designed strength.

Every specification writer and every supervising engineer who is expected to deal with winter concreting should read and digest the abstract mentioned above, beginning on page 35 of the February (1931) issue of "Concrete."

When winter concreting requirements are made sensible, contractors will more willingly comply with them.

A Dangerous Practice in Highway Construction

MUCH publicity has recently been given to a new method of concrete highway construction, in which the concrete, after being placed to a depth about 1⅜ inches above the final slab surface, is compacted to the final level by means of a 3-ton roller.

An experimental road of this type, 1,000 feet long, has been placed in Wisconsin. In a part of the work the cement content was as low as 3.6 sacks to the cubic yard of concrete.

Highway engineers should understand clearly that the Wisconsin project is strictly an experimental road, and that low cement factors can not safely be employed until experimental roads embodying this feature have given satisfactory service over a period of years.

Entirely aside from the experiment in Wisconsin, an unfortunate trend toward low cement factors in concrete highway work has been in evidence for several years. Too often the results of better grading and proportioning of aggregates have been nullified by a reduction in the cement factor. The same has been true of other favorable factors such as improved quality of cement, the use of three sizes of aggregate, and the development of better construction equipment. Too often highway engineers have yielded to the temptation to take advantage of these favorable developments by reducing the cement content, presumably in the belief that the slab will still have sufficient strength for all practical purposes.

Engineers who are guilty of this practice have lost sight of the fact that in concrete highway pavements the element of density is of greater importance than the element of strength, if the slab is to resist the destructive action of frost.

So far as our present knowledge goes, nothing has occurred that will justify the adoption of low cement factors as a means of "economy." Highway engineers who overstep the bounds of good judgment in this matter are taking long chances with other people's money.

PROGRESS—In a Page

Current activities in research, in matters pertaining to concrete and cement, as being carried on or completed by various organized groups.

Submit Tentative A. S. T. M. Standard for Concrete Masonry Units

THE Subcommittee of Committee C-10 on Hollow Masonry Building Units began its work toward the preparation of specifications for concrete units about a year and a half ago. Since then a proposed tentative standard has been submitted to letter ballot of the committee on three occasions. The committee as a whole has been in substantial agreement as to the desired provisions in the specifications with the exception of the paragraph dealing with the strength requirements. Data resulting from tests of a large number of concrete masonry walls were presented in papers at the last annual meeting of the society. Partly as a result of the papers presented, the paragraph on strength requirements has been revised in a manner that has met with approval of the majority of the members of the committee.

The serial designation assigned to this new tentative standard is C90-31T.

Specifications for Concrete Irrigation Pipe

THE American Concrete Pipe Association committee on Irrigation Pipe Specifications, of which H. W. Chutter, P. O. Box 914, Fresno, Calif., is chairman, is developing a new standard specification covering concrete irrigation pipe.

A preliminary draft of the proposed specification was presented for criticism and discussion at the annual meeting of the California Associated Concrete Pipe Manufacturers held at Fresno, Calif., on September 4 and 5, 1931.

The A. C. P. A. committee is now revising the draft of the proposed specifications in the light of the criticisms developed during the discussion in Fresno.

Specifications for Curing Concrete

AT THE last annual meeting of the American Society for Testing Materials Committee C-9 on Concrete and Concrete Aggregates submitted five tentative specifications relating to the curing of concrete. These were promulgated under the sponsorship of Subcommittee XIII on Curing of Concrete. The tentative specifications so promulgated include:

(1) Tentative Specifications for Curing Portland Cement Concrete.

(2) Tentative Specifications for Curing Portland Cement Concrete Slabs with Bituminous Coverings.

(3) Tentative Specifications for Curing Portland Cement Concrete Slabs with Calcium Chloride Admixture.

(4) Tentative Specifications for Curing Portland Cement Concrete Slabs by Surface Application of Calcium Chloride.

(5) Tentative Specifications for Curing Portland Cement Concrete Slabs with Wet Coverings.

In addition, the committee now plans to prepare specifications covering the curing of portland cement concrete slabs with sodium silicate and for curing concrete in cold weather.

Copies of the tentative specifications listed above may be obtained from the American Society for Testing Materials, 1315 Spruce St., Philadelphia.

Cement Company Sponsors Research at Mellon Institute

DR. EDWARD R. WEIDLEIN, director, Mellon Institute of Industrial Research, Pittsburgh, Pa., has announced the foundation of an industrial fellowship by the Green Bag Cement Company of Pittsburgh, subsidiary of the Davison Coke and Iron Company. The investigational work of this fellowship, which will be carried on by Raymond C. Briant, will be concerned with studies of the chemical and physical properties of portland cement and with the development of certain new cement products.

Mr. Briant has come to Mellon Institute from the United States Bureau of Standards, Washington, D. C., where, during the past several years, he has been engaged in research under the auspices of the Portland Cement Association. He was previously employed in the portland cement industry of eastern Pennsylvania, following the completion of his chemical engineering education at Lafayette College.

Investigate Subgrade Soils in Michigan

THE 1931 Proceedings of the Annual Conference on Highway Engineering, held at the University of Michigan, contains two valuable papers on studies of subgrade soils.

"Studies of Frost Heaves in Michigan" is the title of the first paper, by A. C. Benkelman, research engineer, Michigan State Highway Department, who describes tests conducted in a specially built cold room 9 by 12 ft. in size in the state highway department laboratory at the University of Michigan.

"Application of Soil Science to Highway Engineering," by Victor R. Burton, deputy state highway commissioner of Michigan, is the second paper, which deals with problems such as frost heaving and frost boils, and the settlement difficulties arising from thawing in the spring season when the subgrade soil is in a supersaturated condition and has practically no supporting value.

A. S. T. M. Committee on Mortars for Unit Masonry

THE organization of the new A. S. T. M. Committee C-12 on Mortars for Unit Masonry was held in Chicago on June 24, with Prof. R. E. Davis, University of California, Berkeley, Calif., presiding as temporary chairman.

The scope of this new committee is to include the gathering and classification of knowledge regarding properties and tests of mortars for unit masonry. From this knowledge the committee expects to develop specifications and methods of tests pertaining to such mortars.

Unusual Construction Methods Build Schuylkill River Bridge

Forms for Concrete Arches Suspended from Overhead Trusses—Concrete Protected Against Cold Weather—Sinking of Caissons Called for Skill—Channel Kept Open for River Traffic

By M. E. MITCHELL

OVERCOMING some of the most perplexing problems by the use of new methods of engineering practice, the new bridge of the Pennsylvania Railroad over the Schuylkill River in Philadelphia, which will carry electric trains into the heart of the city, has recently been completed by the Dravo Construction Company, of Pittsburgh. The construction of this concrete span has occupied the attention of constructors and engineers throughout the east for more than a year. Among other things it involved protection of concreting operations against the effect of cold weather.

Abutments and Pier Supported on Caissons

The bridge, a trapezoid in plan, consists of two 172-foot concrete arch spans, with all external surfaces faced with Pennsylvania sandstone above a plane of 2 feet below mean water, and granite on the lower 8 feet. Both arches are skewed—the south face about 1 degree and 47 minutes and the north face 4 degrees. They are supported by two abutments, 132 feet along the west, from which point the tracks converge to the narrow base, 96 feet wide, at the east abutment, and center pier. These are sunk as pneumatic caissons to rock, the depth of which varies from approximately 50 feet below high tide on the west bank, to 35 feet below high tide on the east abutment. The width of the bridge varies 40 feet from the east to the west end. due to the necessity of branching out from four to six tracks between the limits of the bridge.

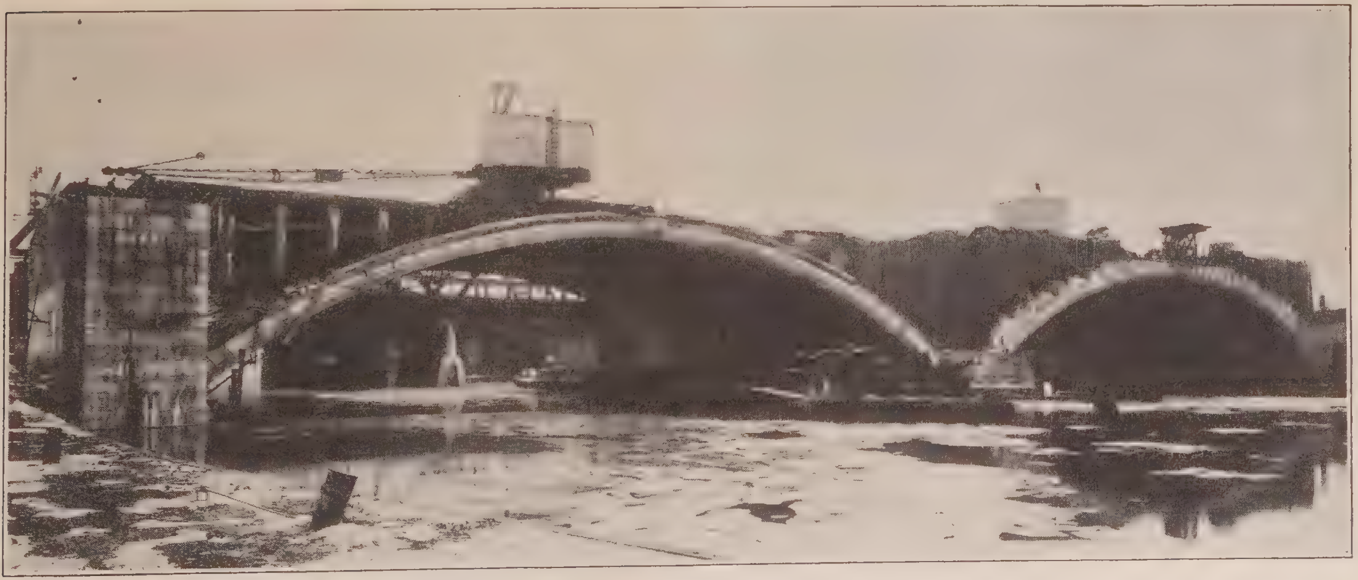
The rise of the arches is excessively low for the loading which they will receive, the distance from the spring line to crown of the arch being only 31 feet. To carry the unusual thrust on the abutments in the center pier, the west abutment was constructed 58 feet wide by 163 feet and 3 inches long, the center pier 37 feet by 166 feet and 6 inches, and the east abutment 50 feet by 123 feet and 6 inches. The concrete deck was supported by cross-walls with 10-foot centers.

Solid spandrel walls of concrete faced with sandstone are supported directly on the arch, and are keyed into the cross-walls. Except for small ventilating panels along the top, these are entirely closed. They have expansion joints above the spring lines.

Form Work Supported by Overhead Trusses

Due to the inadvisability of blocking the channel to river navigation during the construction of the bridge, the regulation method of supporting the forms by wooden falsework beneath the proposed arch was considered undesirable. To solve this problem of supporting the arch centering, a remarkable departure in construction methods was adopted.

Overhead trusses were carried on the pier and abut-



Tarpaulins protected the freshly concreted cross-walls against cold weather ments on framed steel bents resting on I-beam grillages designed so that it was possible to shift the trusses from one section of the arch ring to the next. Each truss consisted of twenty panels of 8½ feet each and two end panels slightly larger, having a total length of about 193 feet and a rise of 30 feet, erected on framed bents resting on piling. Because of the varying width of the ring sections, four trusses were required for the west span and three for the east span. The trusses were spaced 8 feet on centers.

Movable tension rods arranged in pairs supported the centering. The rods were carried on seats riveted to both sides of the webs of 12-inch steel beam vertical posts of the trusses. The centering consisted of 6-inch wood lagging carried on pairs of 20 to 35-inch channels, curved to correspond with the required radius. The lagging for the centering of each span was divided into seven panels to provide easy removal.

Placing of the voussoir stones began when the lagging was completed. Reinforcing steel and bulkheads were placed while the stone setting was in progress. Concreting began as soon as the keystone was set.

Pursuant to the placing of concrete in the keys a period of fourteen days for curing was permitted. The centering was then released by slacking off the tension rods and taking the bolts from the channel rib splices. They were then lowered to barges by large cranes.

Close view of hangar rods attached to overhead trusses, to support the arch form work. Rubber washers distributed the load evenly to the various rods

This method of using overhead trusses to carry the wooden arch forms, and the necessity of constructing two of the largest steel pneumatic caissons ever built, represented two cases of rare engineering practice. One of these caissons, which was fabricated at the Dravo Company's plant in Pittsburgh, was assembled and launched at its yards at Wilmington, and towed to the position it occupies.

Foundation Work Required Skill

In all, the foundation consists of three pneumatic caissons of unusual length, which required particular care in sinking. The fastest progress made was in sinking the east caisson, which was submerged 19 feet in 20 days. In sinking the steel floating caisson for the west abutment 12 shafts seven feet in diameter were used. This gigantic caisson was one of the largest steel pneumatic type ever sunk for bridge foundations. A concrete caisson 123½ by 50 feet was built in place on a steel cutting edge within a cofferdam of steel sheet piling for the east abutment.

The heavy loads supported by the bridge may be realized from this view of the completed deck, with track ballast in place

The Dravo Company is also the constructor of the University bridge over the Schuylkill and the South Street bridge over the Schuylkill in Philadelphia.

Coming Conventions

November 17-18—Portland Cement Association, annual meeting. Blackstone Hotel, Chicago, Ill.

December 10-11—Highway Research Board, National Research Council, eleventh annual meeting. National Academy of Sciences auditorium, Washington, D. C.

January 9-15—American Road Builders Association, twenty-ninth annual convention and road show. Municipal Airport Building, Detroit, Mich.

January 19-22—National Crushed Stone Association, fifteenth annual convention. William Penn Hotel, Pittsburgh, Pa.

January 25-26—National Ready-Mixed Concrete Association, second annual convention, William Penn Hotel, Pittsburgh, Pa.

January 27-29—National Sand and Gravel Association, sixteenth annual convention, William Penn Hotel, Pittsburgh, Pa.

March 1-4 — American Concrete Institute, twenty-eighth annual convention. Wardman Park Hotel, Washington, D. C.

Cutting Corners in Concrete Structural Design

Bending Moments in Continuous Beams with Various Loads Solved by Use of Formulas and Chart

III—Partial and Discontinuous Loadings on Continuous Beams

By J. R. GOETZ
Structural Engineer, Chicago, Ill.

PROBABLY the greatest bugbear for the designer of reinforced concrete buildings is the problem of continuous beams with various conditions of concentrated and partially continuous uniform loadings. Owing to the nature of the formulas involved, the computation becomes a tedious operation if several spans, with widely varying loadings, are figured by the theorem of three moments. The writer has found that the use of the curves given on Chart 3 has cut nearly 50 per cent from the time and labor needed to solve the ordinary run of beam problems encountered in the design of concrete buildings.

Six Conditions of Loading

Referring to Figure 1, it will be seen that there are six conditions of partial uniform and concentrated loads encountered in any two adjacent spans. Notice also that the right hand side of the moment equation under each sketch is made up of two terms, each term referring to its respective span. The coefficients within the parentheses, containing powers of "*k*," are given names, such as A_1, A_2, etc., and refer to the curves of the same name on the chart. Thus, for finding the value of

$$\left[\ 1/4 - k_2^2 + k_2^3 - \frac{k_2^4}{4}\ \right]$$

(and which is referred to as Condition B_2), look up the coefficient from Curve B_2 for any value of "*k*" desired.

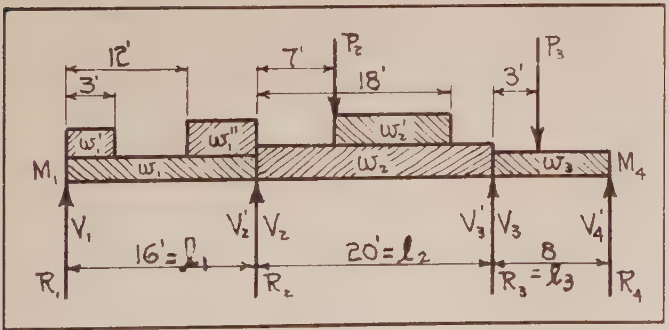
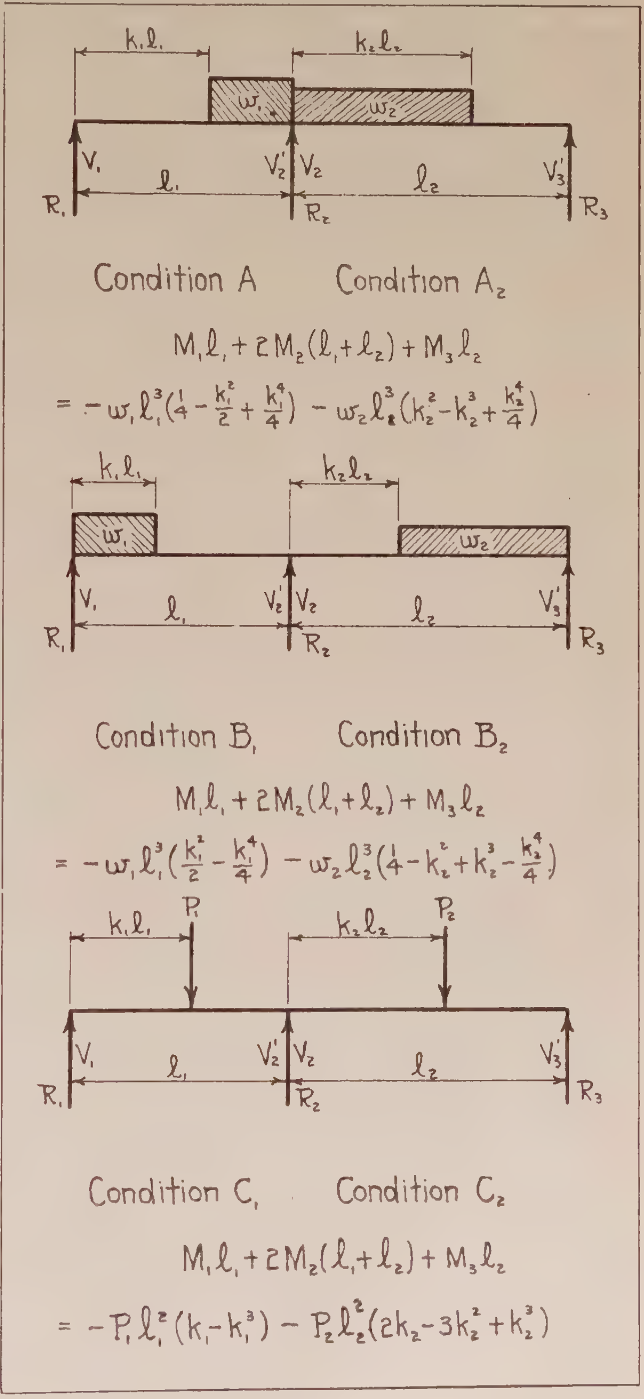


Figure 2

Example:

Given three unequal adjacent spans, loaded as shown in Figure 2. Assuming that the end moments M_1 and M_4 are equal to zero, and that the moments of inertia are the same in all spans, we can write one equation for the first two spans, involving M_2 and M_3, and another equation for the last two spans, also involving M_2 and M_3.



Condition A Condition A_2

$$M_1 l_1 + 2M_2(l_1+l_2) + M_3 l_2$$

$$= -w_1 l_1^3\left(\frac{1}{4} - \frac{k_1^2}{2} + \frac{k_1^4}{4}\right) - w_2 l_2^3\left(k_2^2 - k_2^3 + \frac{k_2^4}{4}\right)$$

Condition B_1 Condition B_2

$$M_1 l_1 + 2M_2(l_1+l_2) + M_3 l_2$$

$$= -w_1 l_1^3\left(\frac{k_1^2}{2} - \frac{k_1^4}{4}\right) - w_2 l_2^3\left(\frac{1}{4} - k_2^2 + k_2^3 - \frac{k_2^4}{4}\right)$$

Condition C_1 Condition C_2

$$M_1 l_1 + 2M_2(l_1+l_2) + M_3 l_2$$

$$= -P_1 l_1^2(k_1 - k_1^3) - P_2 l_2^2(2k_2 - 3k_2^2 + k_2^3)$$

Figure 1

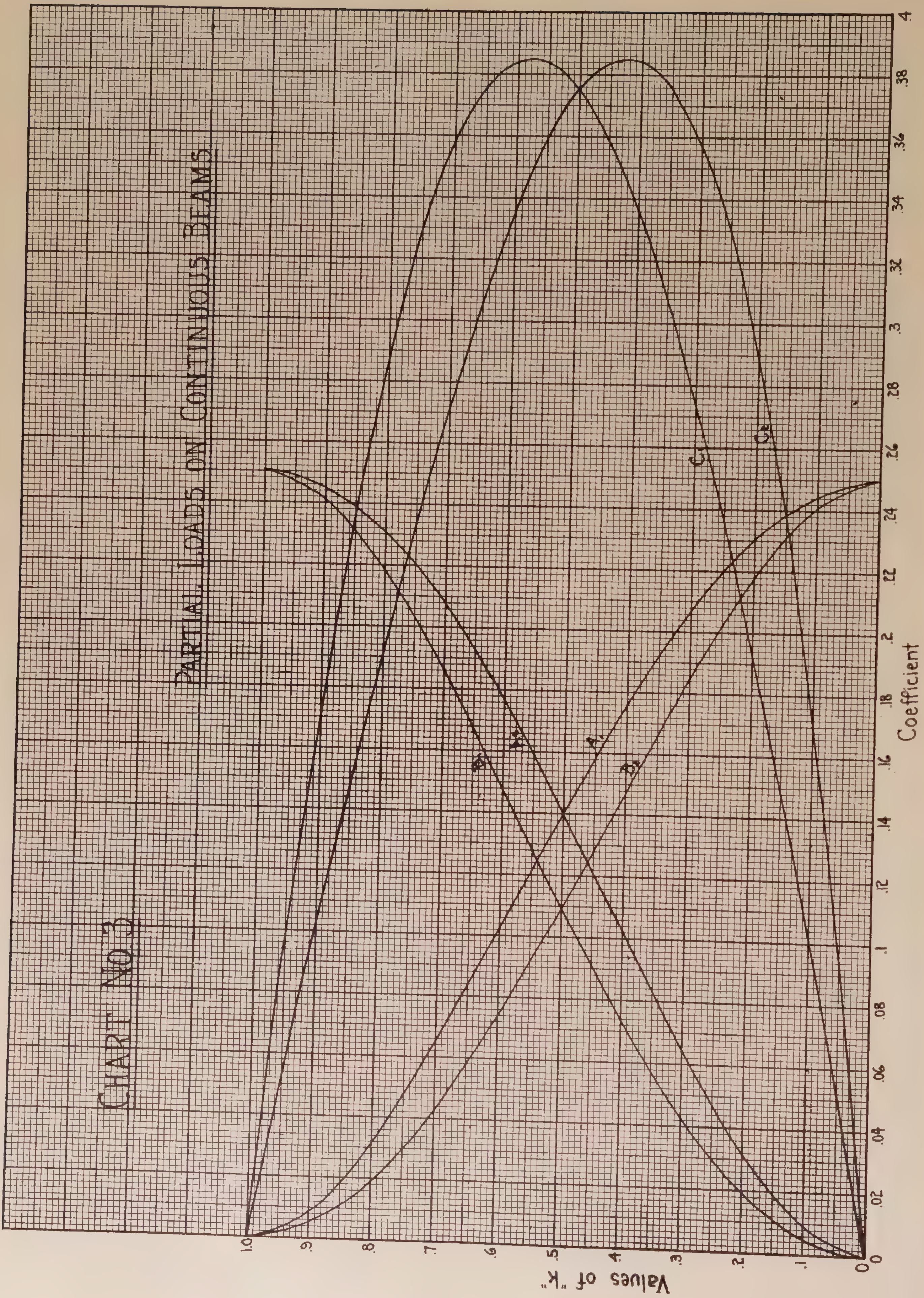


CHART NO 3
PARTIAL LOADS ON CONTINUOUS BEAMS
B2
A2
A1
B1
C1
C2
Values of "K"
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
Coefficient
0
.02
.04
.06
.08
.1
.12
.14
.16
.18
.2
.22
.24
.26
.28
.3
.32
.34
.36
.38
.4

First, from Figure 2, considering spans l_1 and l_2—
$k_1 = 1.0$ —From Curve B_1 the coefficient $= 0.25$
$k'_1 = 3/16 = 0.1875$
—From Curve B_1 the coefficient $= .017$
$k''_1 = 12/16 = 0.75$
—From Curve A_1 the coefficient $= .048$
$k_2 = 1.0$ —From Curve A_2 the coefficient $= .25$
$k'_2 = 7/20 = 0.35$
—From Curve A_2 the coefficient $= .083$
—From Curve C_2 the coefficient $= .376$
$k''_2 = 18/20 = 0.9$
—From Curve A_2 the coefficient $= .245$

Then Equation No. 1, for the first two spans, is—
$0 + 72M_2 + 20M_3 = -4{,}096\ [.25w_1 + .017w'_1 + .048w''_1] - 8{,}000\ [.25w_2 + (.245 - .083)\,w'_2] - [400 \times .376]P_2$.

Also, from Figure 2, considering spans l_2 and l_3—
$k_2 = 1.0$ —From Curve B_1 the coefficient $= 0.25$
$k'_2 = 0.35$ —From Curve B$_1$ the coefficient $= .057$
—From Curve C_1 the coefficient $= .307$
$k''_2 = 0.9$ —From Curve B_1 the coefficient $= .241$
$k_3 = 1.0$ —From Curve A_2 the coefficient $= .25$
$k'_3 = 3/8 = 0.375$—From Curve C_2 the coefficient $= .376$

Then Equation No. 2, for the second and third spans, is—
$20M_2 + 56M_3 + 0 = -\ 8{,}000\ [.25w_2 + (.241 - .057)\,w'_2] - [400 \times .307]\ P_2 - 512\ [.25w_3] - ([64 \times .376]P_3$.

After substituting the proper values of *w* and *P*, the right-hand sides of both equations reduce to numerical values, and the two equations are then solved simultaneously for values of M_2 and M_3. Knowing these negative moments over the supports, the positive moments and the shears are then found in the usual manner.

Profitable Manufacture of Concrete Building Units

Use of Forms in Plant Record System—Stock Inventory Account—Handling of Payroll on Books—Profit and Loss by Days

IX—Plant Record System

Part 2

By FRED A. SAGER
Consulting Industrial Engineer

In this second part of the chapter on the plant record system, Fred A. Sager tells in detail the forms to use, what essential information to enter on them, and why.

He gives considerable attention in this installment to the method of handling the payroll account.—The Editors.

IT was suggested in the last article that the essential information as to plant operations could be set forth in one book. The records shown as Forms 1 to 11 make use of a Standard Figuring Book, with seven triple columns to a 10 by 12-in. page. In a plant where stenographic help is available for clerical work, a loose-leaf typewritten system is usually used, with suitable forms for the records. But in a small plant where the records often have to be kept by one person who is salesman and general manager, the consolidation of these records between two covers has an advantage, particularly if work on the records end of the business may have to be done at home.

Source of Entries

The entries in the records shown herewith are made from the original sources of information—delivery tickets for materials received and for product shipped, and from the Daily Plant Report, the form of which was shown previously.

The forms as shown occupy about one-third of the page; while in practice they will use the entire page of 43 lines, which gives space for the 31 days of the month, with ample room below the total line for any computations that may be desirable.

Cement Form

Forms 1 to 4 have to do with raw materials and show receipts, use, and stock on hand for these items. In Form 1—Cement—there is shown the receipt of 200 bags on Jan. 2, Ticket No. 5572, from which this posting is made. The cement used each day is posted from the Daily Plant Report, which also is the source of similar information as to Cinders, Fuel and Reinforcing Rods, Forms 2, 3 and 4.

In case cement is received by the carload, the entry would be similar to that for Jan. 30, in form 2—Cinders—where the car and initial and quantity received is noted. The On Hand or Stock column can be used daily if desired, but must be figured and filled in at the end of each month. For a check on the accuracy of this record, the plant record should report the exact stock on hand frequently, when convenient, as when stock is out or low. This, together with an actual count of quantity on hand at the end of each month, should maintain the accuracy of this record.

The total cement used for the month, times the unit cost of cement, is the basis for entry in the accounting record, the Journal, of the cost of this item of expense. Likewise, the total received as shown in Form 1, times the unit price, is a basis of checking the invoice for cement delivered that month. The form as shown uses two columns per month, or three months to the page.

Form for Cinders

Form 2—Cinders—uses one page to the month and includes columns for entering the cost of the cinders, which is the cost of the car of cinders—$10—the freight, the labor, and the electric power used in unloading and crushing the cinders. Entering these costs in this form is only for convenience in determining the unit cost for the month. The journal entry as to cost of cinders does not arise in this form, but from the freight bill, the payroll record, etc.

If taken from those sources and set down in Form 2, the weighted average cost of cinders on hand at the end of the month can be calculated as shown, and both the quantity of cinders and the cost will be carried to the first line of the next month's record. And this amount should agree with the ledger account for this item, a valuable check on the accounting records. Likewise, the amount on hand should be checked at the end of each month, by estimating the quantity in storage bins or piles. With bins this is quite easy, but with storage piles it is less accurate.

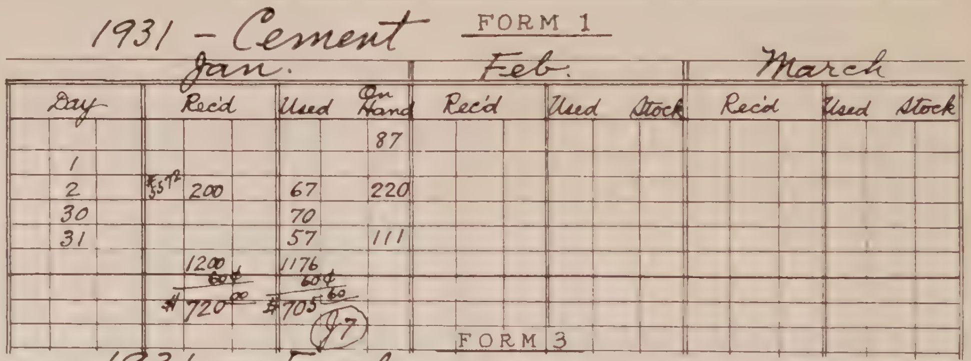
Again every occasion of low stock should be noted as more accurate estimates can then be made, and if cinders are not measured into the mixer, it is quite necessary frequently to check the amount of cinders estimated per unit of product in order to keep this charge accurate. The charge to the cost of manufacture is entered in the journal from the computation of cost of material used as shown under column "Used" in Form 2. It possibly should be stated that in all of these forms entries are shown for two days at the beginning of the month, and two days at the end, to save space, and that on the full page form some 10 lines are available for such calculations.

Fuel and Reinforcing Rods

Forms 3 and 4 are similar, and as shown use one column per month, or two pages per year. The journal entry for cost of these materials, Fuel and Reinforcing Rods, has its origin from the calculations at the bottom of the "Used" column. The ledger balance for these items can also be checked by applying the unit cost price to the stock at the end of the month.

Finished Product Form

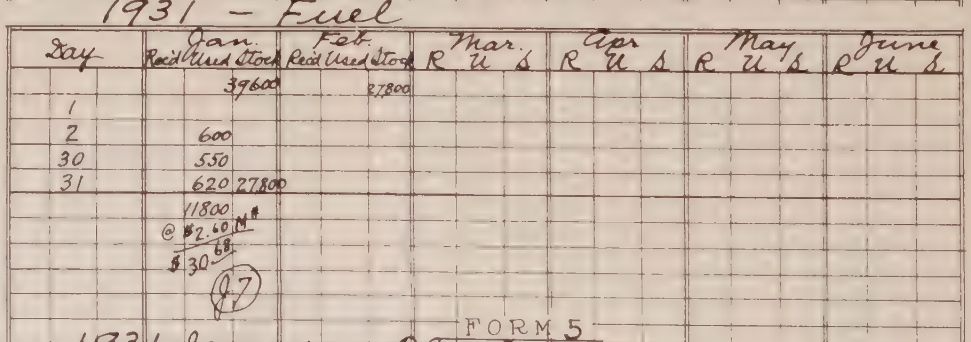
Form 5 is the record of block or finished product, and is shown only in part in this form. One column is used for each item of production, and in an ordinary building unit plant, four to six pages will be required. When more than 11 items are listed, over two pages will be used, in which case the second sheet is cut back one column in order that the last column of this form may always be seen, i. e., the total in equivalent 8-in. units. Six pages, or 35 items, will usually be ample, making 72 pages of the book for the year's record. For each month, the first and sixth pages will be full width, and the second to fifth pages only six columns wide.



1931 – Cement

FORM 1

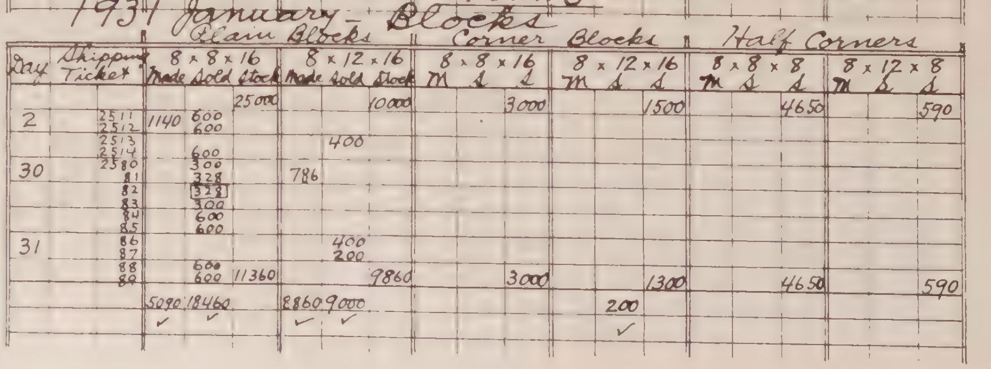
Day	Jan. Rec'd	Used	On Hand	Feb. Rec'd	Used	Stock	March Rec'd	Used	Stock
			87						
1									
2	#55 T2 200	67	220						
30		70							
31		57	111						
	1200 60¢ $\$720^{00}$	1176 60¢ $\$705^{60}$ J7							



FORM 3

1931 – Fuel

Day	Jan. Rec'd	Used	Stock	Feb. Rec'd	Used	Stock	Mar. R	U	S	Apr R	U	S	May R	U	S	June R	U	S
			39600			27800												
1																		
2		600																
30		550																
31		620	27800															
		11800 @ $\$2.60$ M# $\$30^{68}$ J7																



FORM 5

1931 January – Blocks

		Plain Blocks						Corner Blocks						Half Corners					
		8 x 8 x 16			8 x 12 x 16			8 x 8 x 16			8 x 12 x 16			8 x 8 x 8			8 x 12 x 8		
Day	Shipping Ticket	Made	Sold	Stock	Made	Sold	Stock	M	S	S	M	S	S	M	S	S	M	S	S
				25000			10000			3000			1500			4650			590
2	2511	1140	600																
	2512		600																
	2513					400													
	2514		600																
30	2580		300		786														
	81		328																
	82		328																
	83		300																
	84		600																
	85		600																
31	86					400													
	87					200													
	88		600																
	89		600	11360			9860			3000			1300			4650			590
		5090	18460		8860	9000						200							
		✓	✓		✓	✓						✓							

In this record there is first entered the shipping tickets for the day, the items entered under the given item, and also the equivalent in 8-in. units entered in the last column of the last page of the month's record, as shown in Form 5, where the attempt is made to indicate that the preceding pages of the month's record are torn out to expose the last two columns of the last page.

As the standard book has only 42 lines it may be necessary to enter two or possibly three tickets in one line of space, to keep the month's record within one page of vertical length. Three tickets to the line will provide for 120 tickets per month, and with an average of as low as 300 units per delivery ticket, will take care of 36,000 units per month or 432,000 units per year. With seasonal deliveries, any month may far exceed the average, however, and with greater than 120 tickets per month the month's record would have to be continued to another set of pages.

Credit Ticket

In case of product returned, say the small overrun at the end of a job, a consecutively numbered delivery ticket, marked "credit" should be made out and entered as a credit, indicated in a plain manner, as by enclosing in a rectangle. For example, ticket No. 2582, of Jan. 30, is for 328 8-in. block and 338 4-in. block, or 497 equivalent 8-in. units, as shown in the last column.

In the case of the 8-in. block, ticket No. 2581 indicates that they were delivered to another job, but the credit entry of the block returned allows the transaction to take place without affecting the stock on hand. Also, such credit shipping ticket must be made out to serve as the basis for the credit on the invoice rendered to the customer returning the block. The item of 338 4-in. units was returned to stock and the credit entry as shown will take care of this for the 4-in. item.

The Daily Plant Report is the basis for the entries under the column "Made" for the various items of manufacture, and in the next to the last column there is entered the day's production in equivalent units. Also the two preceding columns can be filled in to keep in mind the record so far as cement used per block is concerned.

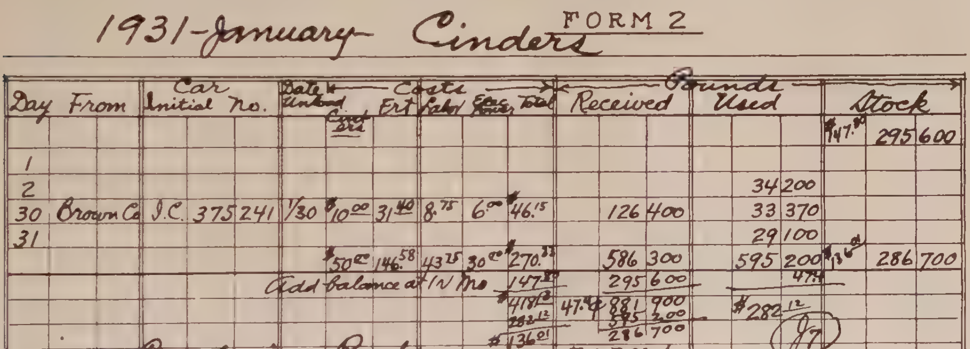
Stock Inventory Record

For each item of production there is shown on the first line the stock at the first of the month. At the end of the month the stock can be figured by the use of the totals of the columns "Made" and "Sold," giving effect to the credits for blocks returned as they may appear in the "Sold" column. This form then becomes the inventory of stock on hand, and if necessary to watch the stock in any given item more closely, the stock on hand by days can be computed and filled in.

The totals for the month for all items made or sold in any given month are carried to columns 4 and 5 in Form 6—Summary of Manufacture and Sales—in which form the second and third columns contain the equivalent of the fourth and fifth columns in equivalent 8-in. units. The totals of the equivalent units (cols. 2 and 3, Form 6) must agree with the totals of the last two columns of Form 5, Blocks, and this serves as a valuable check as to error in entries in Form 5—the block record—and any checks that will prevent errors from creeping into stock records are quite worth while.

Shipping Tickets

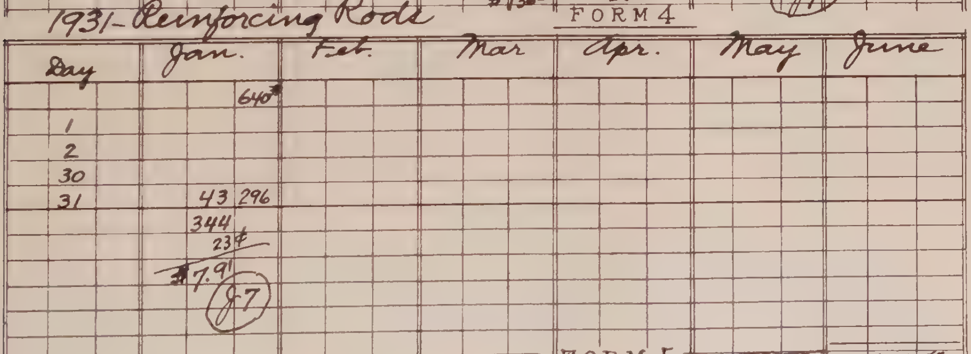
All delivery tickets should be entered in Form 5, even if they are used occasionally for shipping out other items such as empty cement bags. Check should be made at all times to see that no numbers are omitted, and if a ticket is mutilated or voided for any reason, its number should still be entered and its disposition indicated. For correct records every shipping ticket must be accounted for. If used to bill out other material than block



FORM 2

1931-January Cinders

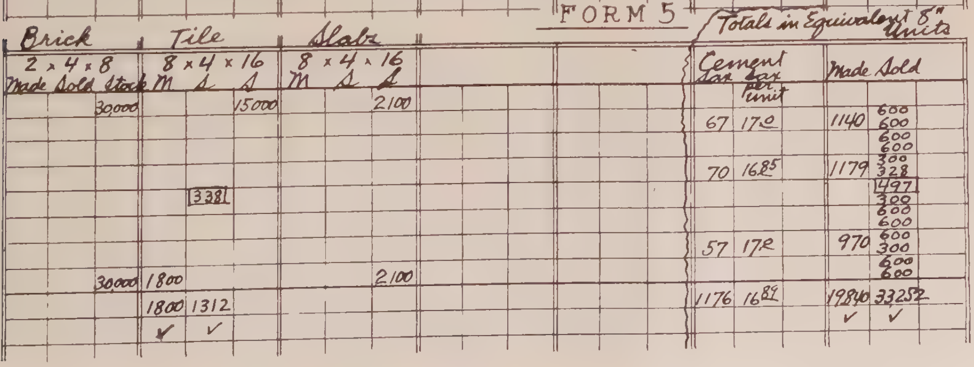
Day	From	Car Initial	Car No.	Date Unload	Costs: Cinder Del	Frt	Labor	Exc. Power	Total	Pounds Received	Used	Stock
												$147.80 295 600
1												
2											34 200	
30	Brown Co	I.C.	375 241	1/30	$10.00	31.40	8.75	6.00	$46.15	126 400	33 370	
31											29 100	
					$50.00	146.58	43.25	30.00	$270.33	586 300	595 200	$136.01 286 700
				Add balance at 1/1 Mo					147.80	295 600	47.4	
									$418.13	47.4¢ 881 900	$282.12	
									282.12	595 200	J7	
									$136.01	286 700		



FORM 4

1931-Reinforcing Rods

Day	Jan.	Feb.	Mar	Apr.	May	June
	640#					
1						
2						
30						
31	43 296					
	344					
	23¢					
	$7.91					
	J7					



FORM 5

Brick 2×4×8 Made	Brick Sold	Brick Stock	Tile 8×4×16 M	Tile S	Tile S	Slabs 8×4×16 M	Slabs S	Slabs S	Totals in Equivalent 8" Units: Cement Sax	Sax per unit	Made	Sold
		30,000			15000			2100				
									67	17.0	1140	600 600
												600 600
									70	16.85	1179	300 328
				338								497
												300 600
												600
									57	17.2	970	600 300
												600 600
		30,000	1800					2100				
			1800	1312					1176	16.89	19840	33252
			✓	✓							✓	✓

sold, its nature should be indicated in this block record, Form 5. The billing or invoices for all block shipped must be checked with this block record, to prevent errors in billing, as a third check of the accuracy of this record will be made by comparing the total equivalent units invoiced against the totals sold in Forms 5 and 6. With these three comparisons made, the errors in these records and in billing are negligible.

Record of Block Made and Sold

As stated above, the totals of block made and sold in any month are entered in Form 6, the principal use of which is to figure the value of block made and sold, both on the basis of cost in the stock-pile. It is assumed here that this shall be a fixed price per item, about 10.5 cents per 8-in. unit. Allowance can and should be made for higher expense of making some units as compared with others and care should be taken to adjust these estimated costs so as to approximate closely the annual cost of manufacture.

Again, it may be noted that a large plant can well afford to figure accurately the month's production and apply a weighted average cost to all items of the inventory of finished products, as was done above with the cost of cinders. Most small plants may not be able to do this, and the method of fixed charge per item can be easily applied. With a uniform production rate, it would have to be adjusted at infrequent intervals. This method will result in showing a profit or loss in manufacture, depending on whether the estimate is too high or too low.

The most satisfactory estimate is one slightly above the average annual cost, which would show a little profit in manufacture. That means that a considerable convenience in financial accounting is accomplished by taking a very slight book profit on product placed in stock. On this basis the Value of Blocks Made is entered in the journal as a debit to Finished Products and a credit to Manufacture, and the value of block Sold is journalized as a debit to Sales and a credit to Finished Products, these entries originating in Form 6.

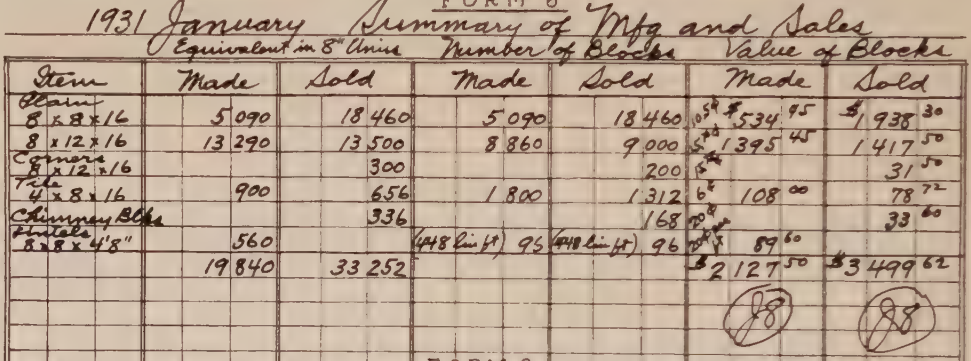
Form 7 collects by months for the year the totals for the month from Form 6 and adds the totals of the quantities of raw materials used. This form shows the volume of manufacture and sales in units by months and for the year, and sub-totals can be carried showing the year to date if desired. The raw materials are added in this form, since tax reports often call for such information, and a proper record will easily collect this information and save much time trying to collect it later.

Daily Cost of Manufacture

Form 8 shows the cost of manufacture by days for the month, and is simply a copy of the Daily Production Cost Record as shown in the Daily Plant Report (CONCRETE for October, page 27). If the daily cost record is figured, it is worth while entering it in Form 8, where it is easily compared with previous days and where the daily variations can be seen and considered. In this record the overhead is estimated but the last line showing the record for the month should contain the actual figures for overhead, obtained after the books for the month are closed. As indicated in the three sample days shown in Form 8, the cost per unit will vary from day to day.

The total cost for the month of 10.65 cents per unit is high, due to the assumption of only 17 working days in

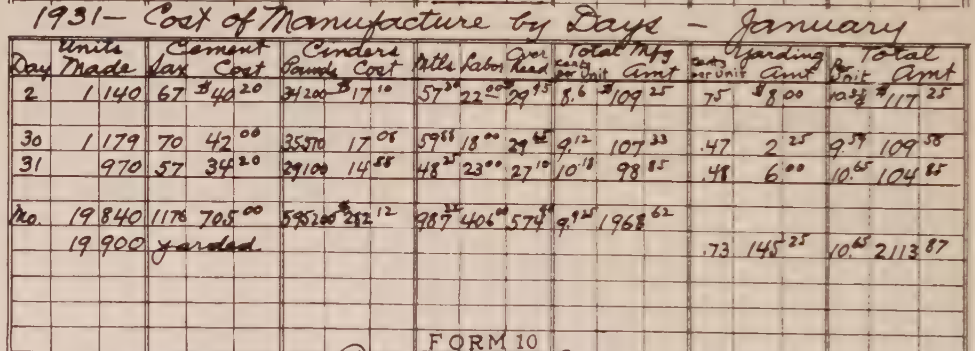
FORM 6



1931 January Summary of Mfg and Sales

Item	Equivalent in 8" Units Made	Equivalent in 8" Units Sold	Number of Blocks Made	Number of Blocks Sold	Value of Blocks Made	Value of Blocks Sold
Plain 8x8x16	5 090	18 460	5 090	18 460	10½¢ $534 95	$1 938 30
8x12x16	13 290	13 500	8 860	9 000	15¾¢ 1395 45	1 417 50
Corners 8x12x16		300		200	15¾¢	31 50
Tile 4x8x16	900	656	1 800	1 312	6¢ 108 00	78 72
Chimney Blks		336		168	20¢	33 60
Lintels 8x8x4'8"	560		(448 lin ft) 95	(448 lin ft) 96	20¢ 89 60	
	19 840	33 252			$2 127 50	$3 499 62

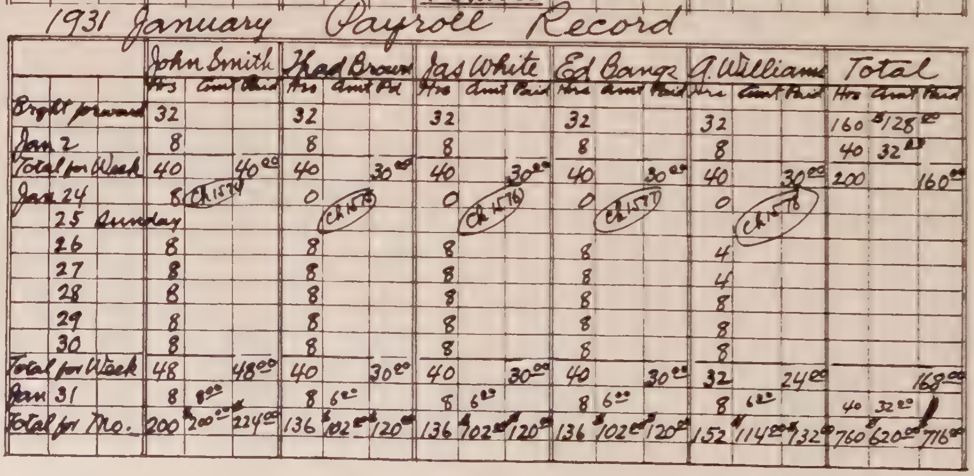
FORM 8



1931— Cost of Manufacture by Days — January

Day	Units Made	Cement Sax	Cement Cost	Cinders Pounds	Cinders Cost	Mtls	Labor	Over Head	Total Mfg cents per Unit	Total Mfg Amt	Yarding cents per Unit	Yarding Amt	Total per Unit	Total Amt
2	1 140	67	$40 20	34200	$17 10	57 30	22 00	29 95	8.6	$109 25	75	$8 00	10.3	$117 25
30	1 179	70	42 00	35570	17 08	59 65	18 00	29 65	9.12	107 33	.47	2 25	9.59	109 58
31	970	57	34 20	29100	14 55	48 25	23 00	27 10	10.18	98 85	.48	6 00	10.65	104 85
Mo.	19 840	1176	705 00	595200	$252 12	987 32	406 00	574 95	9.925	1968 62				
	19 900	yarded.									.73	145 25	10.65	2113 87

FORM 10



1931 January Payroll Record

	John Smith			Ked Brown			Jas White			Ed Bangs			A. Williams			Total		
	Hrs	Amt	Paid	Hrs	Amt	Pd	Hrs	Amt	Paid	Hrs	Amt	Paid	Hrs	Amt	Paid	Hrs	Amt	Paid
Brght forward	32			32			32			32			32			160	$128 00	
Jan 2	8			8			8			8			8			40	32 00	
Total for Week	40		40 00	40		30 00	40		30 00	40		30 00	40		30 00	200		160 00
Jan 24	8	Ck 1574		0	Ck 1575		0	Ck 1576		0	Ck 1577		0	Ck 1578				
25 Sunday																		
26	8			8			8			8			4					
27	8			8			8			8			4					
28	8			8			8			8			8					
29	8			8			8			8			8					
30	8			8			8			8			8					
Total for Week	48		48 00	40		30 00	40		30 00	40		30 00	32		24 00			168 00
Jan 31	8	8 00		8	6 00		8	6 00		8	6 00		8	6 00		40	32 00	
Total for Mo.	200	$200 00	224 00	136	$102 00	120 00	136	$102 00	120 00	136	$102 00	120 00	152	$114 00	132 00	760	$620 00	716 00

the month, as indicated in the payroll record—Form 10. Figured on the same basis, the cost for 340,000 units produced in the year is 10.18 cents per unit, and this was the basis of the assumed 10.5-cent cost per 8-in. unit used in Form 6.

It is not necessary to summarize the monthly figures of Cost of Manufacture, as they are shown in more detail by months in the accounting records. Form 8 and the following Form 9 do not serve as a base for entries in the accounting records, but are simply approximate comparative figures for general information.

Profit and Loss by Days

Form 9 shows the daily profit or loss from sales, by estimating as a fixed charge per day, the overhead sales costs, such as salaries, telephone expense, advertising, and other expenses chargeable to sales. The other items, such as haulage or delivery costs, and the "in stock" value of the product sold can be determined. If this record is kept, net sales price, the haulage, and the value "in stock" should be figured on each delivery ticket for the day, these totaled, say on the back of the last one, and the commission and fixed sales cost deducted to obtain the final result, after which the entry can be made in Form 9, for comparative purposes only. The exact story is told by the book figures at the end of the month as well as by the accounting records.

Payroll Record

The payroll record is usually kept in the regular form of payroll book, and there is no suggestion that Form 10 should be used instead. Form 10 can be used in the book of the makeup illustrated and is satisfactory if men are paid by check. If paid in cash, the regular form with place for signature will be used.

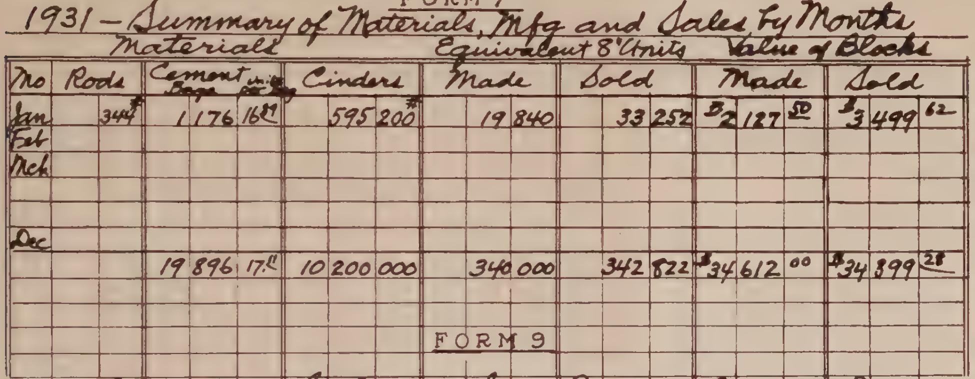
The fact that statements have to be furnished the government of the salaries paid to employes has been considered in the form, which furnishes at the end of each month the amount earned by each man and the amount paid each man in the month.

Accrued Payroll

The record in Form 10 is based on payment on Saturday for the week ending Friday. In 1931, Jan. 2 was Friday, so the accrued hours and money are brought forward from the December record, showing $128 as unpaid as of Dec. 31, 1930. These hours added to Friday's time, Jan. 2, give the week's total payroll as $160, divided as shown between the five men.

The balance of the table shows the last payroll paid in January, ending Jan. 30, to be $168, after which appears the roll for Jan. 31, amounting to $32, accrued but not paid as of Jan. 31. By entering the pay as accrued in the middle column for each man the total for the month can be obtained as shown. The total paid each man is the last column, which for the 5 men is seen to be $716 for the month, with a payroll of $620. This is due, of course, to the $128 accrued Dec. 31 and only $32 accrued Jan. 31.

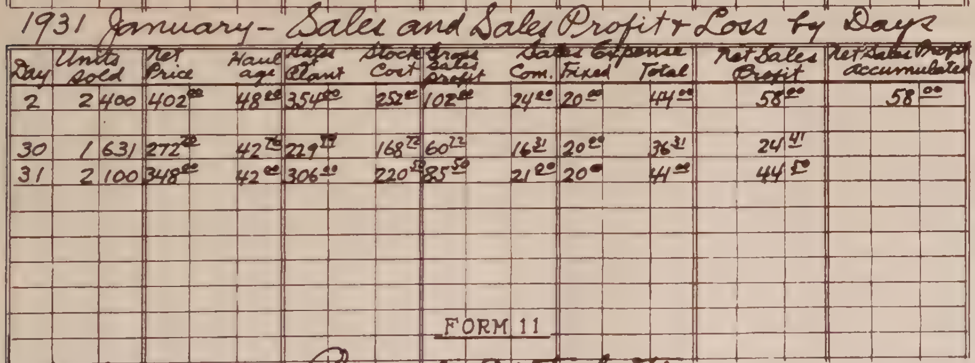
FORM 7



1931 — Summary of Materials, Mfg and Sales by Months

	Materials				Equivalent 8" Units		Value of Blocks	
No	Rods	Cement Bags	per Bag	Cinders	Made	Sold	Made	Sold
Jan	344#	1 176	16^{87}	595 200#	19 840	33 252	\$2 127 ^{50}	\$3 499 ^{62}
Feb								
Mch								
Dec								
		19 896	$17.^{1}$	10 200 000	340 000	342 822	\$34 612 ^{00}	\$34 399 ^{28}

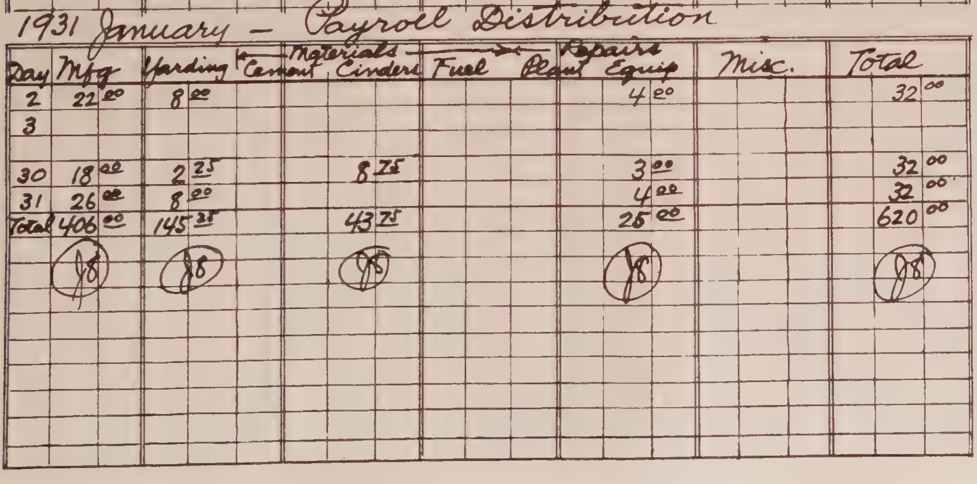
FORM 9



1931 January — Sales and Sales Profit + Loss by Days

Day	Units Sold	Net Price	Haulage	Sales at Plant	Stock Cost	Gross Sales Profit	Sales Expense Com.	Fixed	Total	Net Sales Profit	Net Sales Profit accumulated
2	2 400	402^{00}	48^{00}	354^{00}	252^{00}	102^{00}	24^{00}	20^{00}	44^{00}	58^{00}	58^{00}
30	1 631	272^{20}	42^{75}	229^{44}	168^{72}	60^{72}	16^{31}	20^{00}	36^{31}	24^{41}	
31	2 100	348^{00}	42^{00}	306^{00}	220^{50}	85^{50}	21^{00}	20^{00}	41^{00}	44^{50}	

FORM 11



1931 January — Payroll Distribution

Day	Mfg	Yarding	Materials Cement	Cinders	Fuel	Repairs Plant	Equip	Misc.	Total
2	22^{00}	8^{00}					4^{00}		32^{00}
3									
30	18^{00}	2^{25}		8^{75}			3^{00}		32^{00}
31	26^{00}	8^{00}					4^{00}		32^{00}
Total	406^{00}	145^{25}		43^{75}			25^{00}		620^{00}

Entering Payroll

Now, the Payroll Record is made up from the time record in the Daily Plant Report, from which source the Payroll Distribution, Form 11, is also made up. The total distribution at the bottom of Form 11 is the source of the journal entry debiting manufacture, materials, etc., and crediting Payroll account. The cash entry of payroll checks is a debit to payroll account, and the accrued payroll credit should be the amount carried over at the end of the month from the bottom of Form 10, i. e., the amount of the payroll since the last pay day. This form sets up that figure and has the advantage of this check in the accounts. The payment of the men is evidenced by the number of the check used in payment.

Summarization

A monthly summary of Form 10 gives, at the end of the year, the number of hours worked, wages earned, and wages paid for each man, which is the advantage first mentioned. The payroll accrued must check with the Payroll Distribution, Form 11, and the accrued unpaid must check with the payroll ledger account.

Space Required by Forms

If all of the forms shown were adopted and set up in the 7-column, 10 by 12-in. page referred to, 160 pages would be required, divided as follows:

	Page
Cement	1-4
Cinders	5-16
Fuel	17-18
Reinforcing Rods	19-20
Block	21-92
Block, summary by months	93-98
Summary of Manufacture and Sales	99-110
Summary of Manufacture and Sales by Months	111
Cost of Manufacture by Days	112-123
Payroll Record	124-135
Payroll Distribution	136-147
Sales and Sales Profit and Loss by Days	148-159

This constitutes a suggested simple and yet comprehensive plant record in one volume previously referred to. Some of these records are comparative but most of them are the basis of entries in the books of account which will be briefly described in the final article.

Contracts Let for 1,000,000 Sq. Yds. of Single Lane Pavement in 1931

In thirteen states approximately 1,000,000 square yards of single lane concrete pavements, eight to ten feet wide, were let to contract in the first nine months of 1931. This is the equivalent of a little less than 200 miles of nine-foot pavement.

This year's awards bring the total mileage of single lane pavement in the United States to about 2,600 miles.

Illness Results in Death of Professor W. A. Slater

Willis Appleford Slater, research professor of engineering materials and director of the Fritz engineering laboratory at Lehigh University, Bethlehem, Pa., died at his home there on October 5, after an attack of tonsillitis.

At the time of his death, Professor Slater was engaged in an intensive program of research and was active in engineering groups.

Willis A. Slater

At the outbreak of the war in 1917, Professor Slater was called to the Bureau of Standards as an engineer physicist and detailed to the Emergency Fleet Corporation in connection with the design, construction and testing of reinforced concrete ships. A part of the experimental work connected with this study was done at Lehigh University. As a result of Professor Slater's work in this subject, he was awarded the Wason medal of the American Concrete Institute in 1920. After the war Professor Slater continued with the Bureau of Standards in charge of investigations in reinforced concrete. For a time he was on leave from the bureau as the owner's representative on the construction of the University of Illinois football stadium.

Professor Slater participated in what was said to be the first test made to determine the actual stresses in reinforced concrete building in actual service by measurement of the strains in the floor. He participated in many of the important tests of actual structures made afterward. One of his most spectacular investigations was conducted in 1925, when he was placed in charge of the construction and tests of an experimental arch dam of unreinforced concrete known as the Stevenson Creek dam in California.

He represented the American Society of Civil Engineers on the new Joint Committee on Specifications for Concrete and Reinforced Concrete, of which he was chairman. He was also chairman of the American Concrete Institute's Publications Committee and of Committee 105, Reinforced Concrete Column Investigation.

Professor Slater was born at Polo, Ill., October 14, 1878. He graduated from Polo high school, and later received the degrees of bachelor of science in municipal and sanitary engineering in 1906, master of science in theoretical and applied mechanics in 1910, and civil engineering in 1912, all at the University of Illinois.

He was a member of the American Society of Civil Engineers, the American Society for Testing Materials, American Concrete Institute, American Association of Engineers, Sigma Xi, American Railway Engineering Association, Washington Academy of Sciences, American Welding Society, and American Association for the Advancement of Science.

He is survived by his widow, Mrs. Clara Slater, and a daughter.

HOW TO DO IT

✦ Questions and Answers ✦
Consultation and Comment

A department devoted to the solution of problems encountered in concrete work. Readers are welcome to add to or improve upon the suggestions printed and to submit their views for possible publication.

A Home-Made Absorption Test for Walls of Unit Masonry

In a few weeks a church contract is to be awarded here, involving a building with walls faced with brick and backed up with hollow units.

The members of the building committee, all of whom are well acquainted with our cinder concrete back-up units, wish to have our material specified. The architect, however, tells them that if cinder tile are used the exterior walls will have to be furred and waterproofed, while with clay tile the furring and waterproofing may be omitted, the plaster being applied directly to the back-up.

Can you give me some data which will aid us in disproving the claim of the architect?—E. B. S., Springfield, Ohio.

The architect to whom you refer is probably basing his stand on the erroneous assumption that your cinder tile would absorb more moisture than clay tile. You should have little difficulty in convincing the members of the building committee of the fallacy of this assumption if you can induce them to await the results of a simple, comparative absorption test which can be arranged at your plant.

Such a test, made under circumstances similar to yours, is described and illustrated in the September (1930) issue of CONCRETE, pages 21-23. In that test comparative wall sections were built, with concrete back-up units in one case and clay back-up tile in the other, and with a 4-in. facing of the limestone to be used as exterior facing in the building. The test walls were placed flatwise in a shallow pan, with the 4-in. facing at the bottom, and water was poured into the pan to a depth of 2 in.

By placing the test walls face down in shallow water, you will represent the situation that exists with tile in a wall, when during a rain storm the rain water penetrates the facing material and comes into contact with the outside face of the back-up tile. In the case mentioned above, the concrete units absorbed much less moisture than the clay units, and the former were specified.

The greatest advantage of a "home-made" test of this character lies in the fact that a layman can comprehend it.

Use of Chloride to Prevent Freezing of Concrete

Will calcium chloride or sodium chloride prevent concrete from freezing?—H. B., Franklin Park, Ill.

Within certain limitations calcium chloride and similar compounds may be used in portland cement mixtures to hasten hardening and to increase early strengths. There is evidence to show that calcium chloride and similar compounds do not react in the same manner with all brands of portland cement. Trial batches of the brand of cement and the brand of accelerator proposed to be used should be made up and rate of hardening at the spcified temperature noted before proceeding with their use in important work.

Only small amounts of these admixtures may be used to advantage. For example, the greatest acceleration is obtained with 2 to 4 per cent of calcium chloride by weight of the cement. When such compounds are used in cold weather work, they should not be used in place of heating the materials and furnishing proper protection and heat to the finished work, but only as an added precaution and as a means of shortening the curing period of the concrete.

Manufacture of Concrete Building Block and Tile

I have been told that some American organization has published a pamphlet on the manufacture of concrete building block and tile. Kindly let me know where copies may be obtained.—G. D. P., Paris, France.

The publication to which you refer is probably the "Proposed Recommended Practice for the Manufacture of Concrete Building Block and Tile," prepared by Committee 708 of the American Concrete Institute and printed in the April (1931) *Journal* of that organization, pages 1,001 to 1,020.

Copies of the *Journal* may be obtained from the American Concrete Institute, 641 New Center Bldg., Detroit, Mich., at $1.25 a copy.

Western Newspaper Union Building Load Tests

I recall that some years ago a building of flat-slab reinforced concrete construction, located in Chicago, was subjected to extensive load tests before it was demolished to make room for a public building.

Can you tell me the name of the building as well as the name of some publication in which the tests are described?—F. B. W., Worcester, Mass.

It is probable that you have in mind the load tests made on the Western Newspaper Union Building, in Chicago, in 1918. This test is fully reported in Bulletin No. 106, University of Illinois Engineering Experiment Station, Urbana, Illinois. The latest list of publications of the Engineering Experiment Station includes this report, priced at 20 cents a copy.

New Books and Pamphlets

Rail Steel Bar Specifications and Leaflets

Rail Steel is the title of a revised edition of a 16-page publication issued by the Rail Steel Bar Association, Chicago, Ill.

The booklet is intended for the information of architects, engineers and contractors. It describes the rail steel industry, the manufacture of rail steel bars and the use of this type of reinforcement in concrete construction. The A. S. T. M. Standard Specification for Rail Steel Concrete Reinforcement Bars (serial designation A 16-14) is reprinted in full.

The Rail Steel Bar Association has also issued a set of 4-page folders containing pertinent facts about rail steel bar reinforcement.

Wayne County Highways Report

Twenty-Fourth Annual Report (1930) of the Board of County Road Commissioners of Wayne County, Michigan. Published by the Board of County Road Commissioners, 3800 Barlum Tower, Detroit, Mich. Paper cover, 223 pages, 6 by 9 inches, extensively illustrated.

Copies of this report, describing the past year's work of an organization that has long been a leader in concrete highway development, should be in the hands of every state and county highway department that has to deal with large centers of population. The report describes and illustrates many phases of highway development, such as the construction of new roads, the widening of existing roads, highway service and maintenance, testing of materials, roadside development, widening the right-of-way, bridges, grade separation, and accounting methods.

Haydite Building Units

Haydite Building Units is the title of a 32-page data book for architects and structural engineers recently published by the Haydite Manufacturers' Association, 718 Scarritt Building, Kansas City, Missouri.

The booklet includes data on haydite aggregate and structural concrete, haydite building units and floor systems, and the acoustical properties of this material.

Cast Stone Manufacturer's Brochure

Reconstructed Stone is the name of a 72-page brochure illustrating the paving slabs and curbs, architectural cast stone, and reinforced concrete floors and roofs of the Liverpool Artificial Stone Company, Limited, Liverpool, England.

Booklet on Use of Colored Cement

Coloured Cements, Hints on How to Use Them, is the title of a 24-page cloth-bound booklet, 3¼ by 5¼ inches in page size, issued by G. & T. Earle, Ltd., Hull, England.

The booklet contains a large insert containing instructions for the use of colored cement under various conditions. There is also a table of quantities of cement and aggregates for various purposes.

Organizations

American Association of State Highway Officials; W. C. Markham, Executive Secretary, 1222-24 National Press Building, Washington, D. C.

American Concrete Institute; Harvey Whipple, Secretary, 641 New Center Building, Detroit, Mich.
Twenty-eighth annual convention, March 1-4, Wardman Park Hotel, Washington, D. C.

American Concrete Pipe Association; M. W. Loving, Secretary, 33 West Grand Ave., Chicago.

American Road Builders' Association; Chas. Upham, Engineer-Director, 914 National Press Building, Washington, D. C.
Twenty-ninth annual convention and road show, January 9-15, Municipal Airport building, Detroit, Mich.

American Society of Civil Engineers; Geo. T. Seabury, Secretary, 33 West Thirty-ninth St., New York City.

American Society for Testing Materials; C. L. Warwick, Secretary-Treasurer, 1315 Spruce St., Philadelphia, Pa.

American Standards Association; P. G. Agnew, Secretary, 29 West 39th St., New York City.

Associated General Contractors of America; E. J. Harding, Managing Director, 222 Munsey Bldg., Washington, D. C.

Building Officials Conference of America; Col. John W. Oehmann, Secretary, 1253 Lawrence St., N. E., Washington, D. C.

Canadian Engineering Standards Association; 46 Elgin St., Ottawa, Ontario.

Cast Stone Institute; L. A. Falco, Secretary, Chapel St. and Blatchley Ave., New Haven, Conn.

Cement Institute; Luther G. McConnell, General Manager, 11 East 44th St., New York City.

Concrete Masonry Association; Jack Franklin, Secretary, 7071 Plankinton Bldg., Milwaukee, Wis.

Concrete Reinforcing Steel Institute; M. A. Beeman, Secretary, Tribune Tower, Chicago.

Engineering Institute of Canada; 2050 Mansfield St., Montreal, Quebec.

Highway Research Board; R. W. Crum, Engineer-Director, B and 21st Sts., Washington, D. C.
Eleventh annual meeting, December 10-11, National Academy of Sciences, Washington, D. C.

Joint Committee on Standard Specifications for Concrete and Reinforced Concrete; F. R. McMillan, Secretary, 33 West Grand Ave., Chicago.

National Board of Fire Underwriters; W. E. Mallalieu, General Manager, 85 John St., New York City.

National Concrete Burial Vault Association; J. H. Stuart, Secretary-Treasurer, Bremen, Ohio.

National Crushed Stone Association; J. R. Boyd, Secretary, 1735 14th Street, N. W., Washington, D. C.
Fifteenth annual convention, January 19-22, William Penn Hotel, Pittsburgh, Pa.

National Engineering Inspection Association; B. H. Witherspoon, Secretary, P. O. Box 1115, Pittsburgh, Pa.

National Fire Protection Association; Franklin H. Wentworth, Secretary, 40 Central St., Boston, Mass.

National Lime Association; Norman G. Hough, Secretary and Manager, 927 Fifteenth St., N. W., Washington, D. C.

National Ready-Mixed Concrete Association; V. P. Ahearn, Secretary, 545 Munsey Building, Washington, D. C.
Second annual convention, January 25-26, William Penn Hotel, Pittsburgh, Pa.

National Sand and Gravel Association; V. P. Ahearn, Executive Secretary, 545 Munsey Bldg., Washington, D. C.
Sixteenth annual convention, January 27-29, William Penn Hotel, Pittsburgh, Pa.

National Slag Association; H. J. Love, Secretary-Treasurer, 937 Leader Bldg., Cleveland, Ohio.

National Terrazzo and Mosaic Association; U. F. Durner, Secretary, 815 West St. Paul Ave., Milwaukee, Wis.

Northwest Concrete Products Association; W. P. Hews, Secretary-Treasurer, Yakima, Wash.

Portland Cement Association; Edward J. Mehren, President; William M. Kinney, General Manager, 33 West Grand Ave., Chicago.
Annual meeting, November 17-18, Blackstone Hotel, Chicago, Ill.

Rail Steel Bar Association; H. P. Bigler, Engineering Secretary, Builders' Bldg., 228 N. La Salle St., Chicago, Ill.

Wisconsin Concrete Products Association; Jack Franklin, Secretary-Treasurer, 425 East Water St., Milwaukee, Wis.

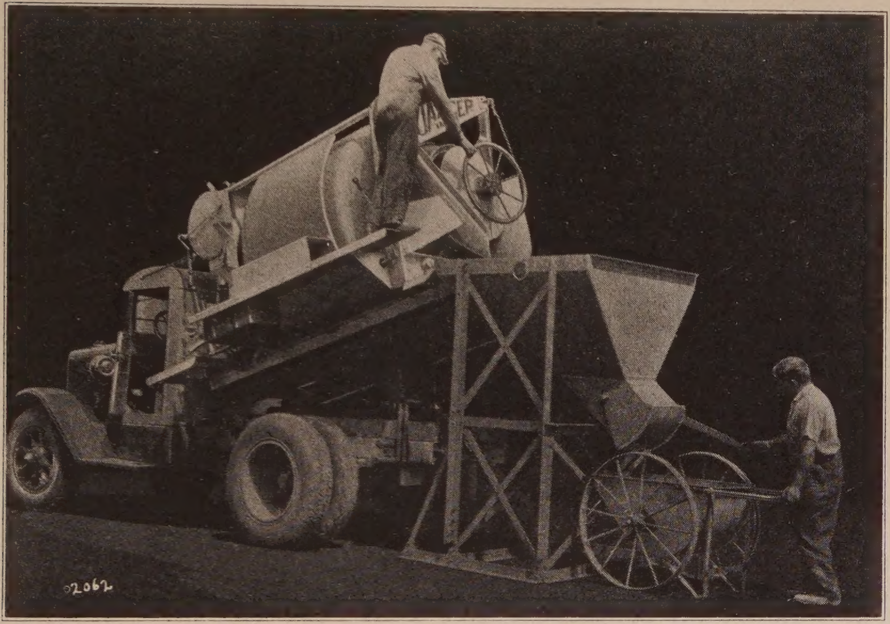
New Equipment and Materials

Jaeger Announces Rear-Lift Hoist Attachment

The Rear-Lift hoist attachment has been designed for use with Jaeger 2 and 3-yd. truck mixers to give extra discharge height and consequent wider chuting area. The attachment can, however, be readily mounted on any standard type of truck, which is equipped with power take-off to drive the hoisting mechanism.

Direct placing into forms otherwise inaccessible and into storage hoppers for wheeling to those not reached by truck is now possible, according to the Jaeger Machine Co., Columbus, Ohio. Alley, road shoulders, the full width of some streets, sidewalks, and inside residence parkways, are included.

The Wood hydraulic positive, double-support hoist is used.



Improved Jak-Tung Truck Announced by Howe Chain Co.

An improved Jak-Tung truck has been announced by Howe Chain Co., Muskegon, Michigan. This improved truck uses as its basic principle the construction of the tote truck.

The Howe Jak-Tung truck is a simply designed unit well adapted for use as a hand truck or trailer, and for the temporary storage of materials, it is stated. A body of hardwood or steel, suitably shaped for the product to be handled, is permanently attached to two rear wheels, with a malleable iron leg supporting the front.

For use as a hand truck, a jack tongue is inserted in the draw bar, and a simple downward movement of the handle exerts a cam action, and elevates the front leg 1¼ in. from the floor, transferring the load to the jack tongue wheel. The truck can then be pulled over rough floors and door sills with a minimum of effort, and accurately spotted in its new location.

To couple the trucks in a tractor train, the truck is brought into position, the jack tongue removed, a trailer hitch inserted in its place, and coupled to the clevis of the preceding truck.

The three wheel construction insures accurate tracking, and permits short turns, and the negotiation of narrow pathways.

The co-ordination of these trucks with overhead monorail systems, and portable stackers, insures a highly efficient and low cost means of material handling, according to the company.

The permanently attached rear wheels and the handle cast integral with the draw bar permit the ready movement of empty trucks without the use of the jack tongue. The inexpensive jack tongues may be had in such quantities (usually one tongue to 15 trucks) that they are readily accessible and render it unnecessary to waste time looking for the usual transportation unit.

The small, light-in-weight jack tongue makes unnecessary the use of wide aisles for storage purposes, as no space accommodation is needed to bring it into action.

This improved Jak-Tung truck is described in Folder No. 129, issued by Howe Chain Company, Muskegon, Michigan.

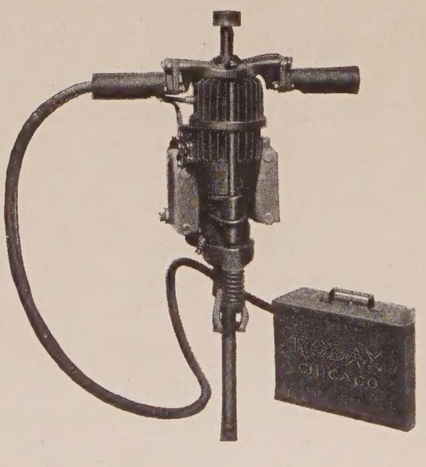
Material Weighing Innovation on Koon Dam

"The first dam in the history of large construction projects to be weighed" will be the new Koon dam, which is to be located in the valley of Evitts Creek, Bedford County, Pa., according to the Toledo Scale Co., Toledo, Ohio, whose newly and especially developed equipment will be used.

All ingredients going into the concrete will be accurately weighed and mixed with proper corrections for the weight of the surface moisture in every batch. The feeding operation is electrically controlled by the scale operator who presses a push button which actuates the flow of each material, and the flow is automatically cut off by the scale when the correct amount has entered the batching hopper. The materials are weighed over a large automatic scale which is equipped with a graphic recording device which records every weighing, the time of weighing and what it has weighed. The batch is then dumped into the mixing hopper by the pressure of an electrical button.

New Model Rodax Hammer Is Brought Out

In spite of its lighter weight, the new model Rodax gasoline-driven hammer distributed by the Rodax Corporation, Chicago, is said to have increased power. It weighs 88 lbs. and strikes approximately 1,000 blows a minute.



It is a single unit having three moving parts, and may be operated by one man. It takes any standard 1⅛-in. shank and is lubricated by the addition of oil to the gasoline. Operating cost is placed at 15 cents an hour.

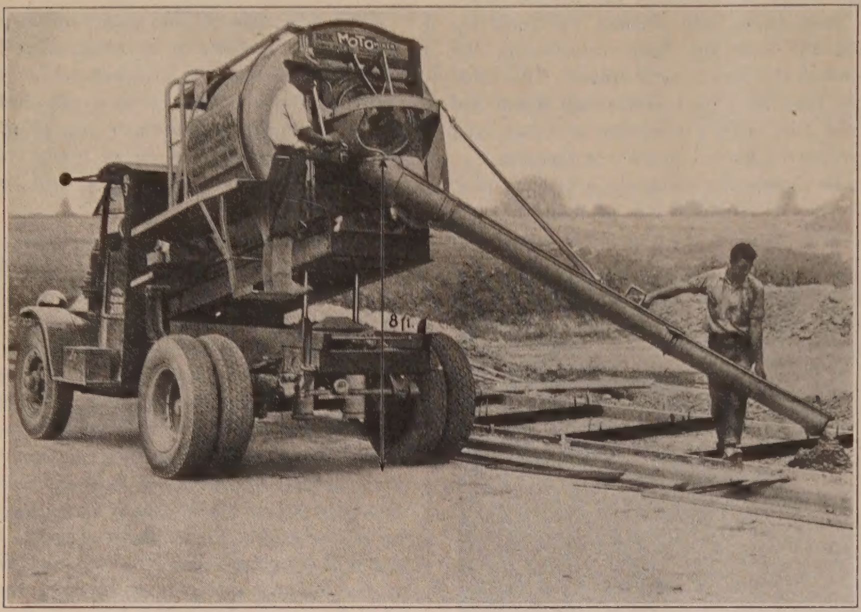
Jackass Hoist Raises Truck Body to Give Spouting Range

The Jackass hoist, with its increase in spouting range, opens new uses and new fields for the truck mixer, according to the Chain Belt Co., **Milwaukee, Wis.**

The Jackass hoist, hydraulically operated, and used on the Motomixer or Moto-Agitator, raises the discharge end of the drum about 8 ft. from the ground. From this height the concrete can be chuted over an area approximately 75 per cent greater than heretofore, it is stated.

Thus, according to the manufacturers, sidewalks can be poured across parkways, without wheeling; building foundations and walls can be chuted even when the truck cannot get within ten to twenty feet of the hole, and alleys and some streets can be fanned their full width. The hoist raises the drum high enough to discharge into a 3-yd. storage hopper without a chute.

The flow of concrete may be regulated from a trickle to a full discharge by a small handwheel.



About the Manufacturers

Manufacturers' News

Pottsco Patent Application Granted

United States Patent No. 1,816,988, dated August 4, 1931, and covering the development of pottsco light-weight concrete, has been granted to *Harry H. Potts*, president of the *H. H. Potts Company*, Chicago. The firm becomes the general licensee of the patent. Application for the patent was filed on May 24, 1930, earlier applications having been filed on February 7, 1930, and October 29, 1928.

The patent granted covers light-weight load-bearing concrete, made of water, portland cement, and an aggregate complying essentially with one of the following three descriptions, the wording of which is quoted from the patent papers:

(1) Hard particles of granulated blast-furnace slag.

(2) Hard reticulated particles of water-granulated blast-furnace slag, substantially 80 per cent of which will pass a 16-mesh sieve and be retained by a 50-mesh sieve.

(3) Particles of blast-furnace slag water-granulated in running water materially below the boiling **point.**

Any user of pottsco aggregate will be given a license under the full provisions of the patent, without any charge, according to Mr. Potts. The manufacturer who has a contract covering the purchase and use of pottsco aggregate will not have to pay any territorial license fee or royalties on his finished product, yet such manufacturers are given an exclusive territory, without limitation of their sales area, it is stated. Pottsco manufacturers may sell pottsco building units wherever they elect, but the company will not award a contract to a manufacturer in any territory held by another manufacturer.

DeVilbiss Price Reduction

A price reduction upon their entire line of Type NC ¼ hp. electric motor-driven portable spray-painting outfits has recently been announced by the *DeVilbiss Company*, Toledo, Ohio.

New Cement Bag Manufacturer

The Universal Paper Bag Co., New Hope, Pa., announces that it is now manufacturing high quality kraft multi-wall paper cement bags. At the same time it announces the appointment of *E. T. Statler* to the multi-wall paper bag sales division.

Bethlehem Acquires Kalman Steel

E. G. Grace, president of the Bethlehem Steel Corp., announces the acquisition of the properties and business of *Kalman Steel Company*, fabricators and distributors of reinforcing steel, concrete accessories for buildings and roads, wire fabric, steel joists, steel door frames and metal lath. This business will be conducted by Kalman Steel Corporation, a Bethlehem subsidiary.

Industrial Literature

Groundhog Concreduct Booklet

A loose leaf, 9 by 11½-in. booklet on *Groundhog Concreduct* has been prepared by *Edward N. Gackenbach*, Jenkintown, Pa.

Illustrations show the machine used, the manufacture, placing, and method of shipment. Dimensions of construction and a list of uses are also given. A consulting engineer's report on the product is given in full.

Septic Tank Manufacture

The manufacture of York septic tank molds is covered in a booklet published by the *York Automatic Sealing Vault Co.*, York, Pa.

Cross section views show the construction of both the tank and the molds. The approximate manufacturing cost is given.

Crown Data Booklet

Crown Data for Roads and Streets is a new booklet published by the *Cleveland Formgrader Company*, Cleveland, Ohio.

It comprises a tabulation of data to give ordinates for various crowns at 1-ft. intervals across the slab as well as at the quarter points. It sells at $1.

Barnsdall Admix Bulletin

The Barnsdall Tripoli Co., St. Louis, Mo., have published a new bulletin (*Bulletin E*), describing the use of Barnsdall Admix as an integral waterproofing for concrete, mortar, stucco, and cement products. This bulletin will be sent to those interested in receiving it.